FEDERAL POLICIES FOR INFRASTRUCTURE MANAGEMENT

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PREFACE

Are we investing enough in infrastructure? Are we choosing the right projects? These two questions lie at the heart of Congressional concerns about the condition of the nation's network of transportation and other basic facilities, as well as its adequacy to support economic and social activities. Current federal policies for infrastructure financing include matching shares and other conditions for capital grants, providing technical and operating standards for facilities, developing rules for appraising and comparing improvement options, and so on. This study, requested by the Economic Development Subcommittee of the House Committee on Public Works and Transportation, examines the ways in which these policies influence the choices made in federal, state, and local budgets of which projects to undertake and how much to spend.

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Director

June 1986

CONTENTS

SUMMARY xi

CHAPTER I MANAGING THE NATION'S INFRASTRUCTURE 1

Budgeting in the Public Sector 1
Evolving Federal Goals in Infrastructure 3
The Federal Resources in Infrastructure Financing 6
Current Proposals for Change 8
A Model for an Infrastructure Management System 9

CHAPTER II IDENTIFYING INFRASTRUCTURE PROJECT OPTIONS 15

Limits on Searches for Solutions 15
Design Standards Versus Performance Standards 18
Eligibility Limits 23

CHAPTER III EVALUATING OPTIONS: MEASURING VALUE 29

Comparable Measures of Value 29
Accounting for Differences in Time 35
The Life Cycle Approach 40
The Use of "Hurdles" Versus Rankings 46
Conclusion 50

CHAPTER IV EVALUATING OPTIONS: CHOOSING A BASELINE 53

The "Nothing Happens" Baseline 53

CHAPTER V INCENTIVES FOR USERS: THE ROLE OF PRICES 63

How Pricing Can Shape Demand 63

CHAPTER VI INCENTIVES FOR MANAGERS: PROMOTING NATIONAL GOALS 73

Managing Program Evolution 73
Incentives for State and Local Agencies 78

CHAPTER VII WAYS TO RECAST THE FEDERAL ROLE IN INFRASTRUCTURE MANAGEMENT 91

Improving Management Information 92
Improving the Incentives to Nonfederal Managers 98

TABLE 1. INVESTMENT PRIORITIES FOR GAPS IN THE INTERSTATE HIGHWAY SYSTEM 26

TABLE 2. COST-EFFECTIVENESS MEASURE FOR NEW TRANSIT STARTS, 1984 37

TABLE 3. CONDITION OF THE FEDERAL AID HIGHWAY NETWORK COMPARED WITH ITS AGE 44

TABLE 4. HIGHWAY PAVEMENT CONDITION BY SYSTEM IN 1975, 1978, AND 1983 47

TABLE 5. TREND OF TRANSIT PASSENGER TRIPS CLASSIFIED BY POPULATION GROUPS, CALENDAR YEARS 1940-1983 60

TABLE 6. PROFILE OF JOURNEYS TO WORK BY MODE OF TRAVEL AND LOCAL POPULATION SIZE, 1980 61

TABLE 7. CURRENT USER FEE OBJECTIVES IN FEDERALLY AIDED INFRASTRUCTURE PROGRAMS 66

TABLE 8. STIMULATION AND SUBSTITUTION EFFECTS OF FEDERAL GRANTS FOR CAPITAL PROGRAMS FOUND BY ELEVEN STUDIES 82

FIGURE 1. FEDERAL AND NONFEDERAL FINANCING AND CONTROL OF INFRASTRUCTURE SPENDING: 1975, 1980, AND 1985 7

FIGURE 2. PROFILE OF PUBLIC INVESTMENT IN PUBLIC WORKS ASSETS FROM 1965 THROUGH 1985: TOTAL INVESTMENT, NET ADDITIONS, AND REPLACEMENTS 12

FIGURE 3. COMPARISON OF 1984 PUBLIC TRANSIT COSTS FOR FOUR VEHICLE TYPES 56

FIGURE 4. FEDERAL AND NONFEDERAL CAPITAL SPENDING ON PUBLIC WORKS INFRASTRUCTURE, 1970-1984 85

FIGURE 5. NONFEDERAL BOND FINANCING BY END USE: 1977-1984 88

BOX 1. MILESTONES IN FEDERAL PUBLIC WORKS MANAGEMENT 4

BOX 2. CURRENT INFRASTRUCTURE MANAGEMENT CONCEPTS--NEEDS ESTIMATES AND CAPITAL BUDGETING 10

BOX 3. IDENTIFYING A BROAD RANGE OF OPTIONS--VALUE ANALYSIS FOR LONDON TRANSPORT-RAIL 17

BOX 4. SEARCHING BROADLY FOR SOLUTIONS--MOBILITY FOR THE HANDICAPPED IN BRITAIN 22

BOX 5. RANKING CHOICES TO SET CITY PRIORITIES 49

BOX 6. EVALUATING OPTIONS--THE BRIDGE REPLACEMENT PROGRAM 51

BOX 7. PRICING INFRASTRUCTURE USE--ROAD PRICING IN SINGAPORE 70

BOX 8. INCENTIVES FOR PROGRAM MANAGERS--CANADA'S ENVELOPES FOR POLICY AND EXPENDITURE MANAGEMENT 74

BOX 9. AGENCY STRATEGIC PLANNING--MAKING CHOICES IN NEW YORK, NEW JERSEY, AND PENNSYLVANIA 79

SUMMARY

Although infrastructure systems have evolved over the nation's first two centuries and have recently taken new directions, federal infrastructure management practices have not matured accordingly. Many federally aided public works programs fail to identify and evaluate in consistent terms the proper mix of new construction, rehabilitation, and operational improvements needed to provide the infrastructure base that a sound economy requires. These failures can lead to overinvestment in inefficient systems, disregard for national rather than local needs, inability to achieve the best use of facilities through pricing, and lack of appropriate and timely information for decisionmaking.

Federal policies play an important role in coordinating the development of the nation's infrastructure. Federal programs are important sources of infrastructure financing for states and local governments. In some cases--principally in national navigation systems--federal programs provide and operate facilities directly. In other instances, as in discretionary programs or demonstration projects, federal agencies approve planning for projects to be undertaken and operated by other governments. Thus, federal grant conditions--both for eligibility and amounts of aid--influence infrastructure development as clearly as do project choices in direct investment programs.

TOWARD A NATIONAL DECISIONMAKING PROCESS

The federal government's most important role in infrastructure provision is as a source of finance. State and local project managers actually select projects for 80 percent of infrastructure investments, but they provide only half the financing needed. Thus, for infrastructure to be managed in a way that furthers national objectives, federal agencies must offer incentives for local managers to align their choices with the welfare and equity goals of federal programs. Choices for infrastructure systems that aim at such broad objectives must similarly be based on wide searches among new investments, rehabilitation efforts, or operational changes. They must also be derived from consistent evaluations of the long-term effects of these possible choices on the efficiency of activities using the infrastructure.

Management systems for infrastructure must consequently be broadly designed to:

- Identify what options are available,
- Evaluate them correctly,
- Implement the choices made.

Identifying Options

Federal programs show mixed results in encouraging sufficiently wide searches for projects that would improve the infrastructure. Too many programs actually discourage wide searches by offering states and localities only narrow ranges of projects eligible for aid. For example, despite growing federal assistance to mass transit, these systems have become increasingly irrelevant to the transportation choices of work-bound Americans. Between 1970 and 1980, the importance of public transportation for journeys to work dropped from 9 percent of all such trips to 6 percent. This drop mirrors the shrinkage in the transit network. Municipally owned bus systems now serve only half of all networks at 60 percent the service frequency of the private 1940s bus lines they replaced. But while mass transit services deteriorate and demand for them declines, transit subsidies are the fastest-growing item in infrastructure budgets. Direct support for capital investments has grown at an average rate (after price adjustments) of 14 percent a year since 1965. Further, nationwide additional investments in urban streets caused by the decline in transit use in the 1970s has been in the range of $3 billion a year.

The failure of federal assistance to promote efficient transit systems in the nation's cities stems from the biased perception that subsidizing transit services was necessary to preserve public transportation following the rapid growth of automobile use and the spread of urban areas during the 1950s and 1960s. Though federal assistance has concentrated on modernizing older transit systems serving travel to central cities, the development of frequent, convenient services between downtown and suburban destinations would have tended to maintain the attractiveness of transit services compared with the automobile.

On the other hand, federal programs that have encouraged broad choices among project types achieve gains in efficiency. Under state management and priority setting for wastewater plant construction assistance, for example, water treatments have evolved that are based on actual water quality rather than on a set effluent-removal technology in attaining clean water goals. Thus, localities have been encouraged to use lower-cost systems for removing pollutants when these are as effective as the technologies approved by the Environmental Protection Agency for federal aid. Cities have recently been granted the freedom to switch federal aid from urban Interstate Highway System construction to other urban transport improvements. This freedom has sharpened their priorities for the selection of projects to complete the Interstate network. Overall, 71 percent of the Interstate highway gaps "traded in" under this program since 1980 would have been poor investments, with zero or even negative returns (losses) had they been constructed. Current federal provisions allowing communities to choose between capital investments and providing special services in promoting the mobility of disabled citizens have also promoted solutions better tailored to local circumstances.

Evaluating Projects

The techniques used to evaluate projects in federal infrastructure programs fall far short of the methods of life-cycle costing and discounting commonly used in the private sector to assess major commercial investments. Federally sponsored appraisals of projects commonly rely on single-year mid-life assessments of a project's effects, which disregard the unevenness of infrastructure investment and the different time profiles of project costs and benefits. Such studies distort views of the resource commitments needed to carry out projects. For example, rating procedures of the Urban Mass Transportation Administration have assessed as "cost-effective" transit projects that, in reality, would divert hundreds of millions of dollars in additional resources to providing in-city transport services. As a result of this approach to project appraisal, city managers have been obliged, within a short time of opening new transit systems, to raise new taxes to cover unexpected operating deficits.

Those federal agencies that do use life-cycle costing typically fail to account properly for the cost of capital. For example, when the current cost of capital is accurately taken into account, some 34 projects on the Corps of Engineers' suggested project list for 1986 provide cumulative benefits over a 30-year period that are less than the $4.4 billion needed to complete construction.

Failure to use analytic methods to guide programs' progress has contributed to the physical deterioration of the Interstate highway network. Highway program management that directed resources to improvements having the greatest effects on transport efficiency, for example, would favor repairs on densely traveled corridors in poor or fair condition (the Interstates), and on only the worst segments of other systems. But the proportion of the Interstate urban highway network (the most heavily traveled of all Federal-Aid highways) in poor or very poor condition has doubled since 1975. In the same period, the extent of poor or very poor segments on rural Interstate highways (the next most densely traveled) has increased by 30 percent. Most of this reflects deterioration of highways that were in good or very good repair. Relatively lightly trafficked arterial and collector highways, on the other hand, have broadly improved their condition, with significant improvements of roads from good to very good rating. Highway status reporting, which relies on current-condition assessments and future needs estimates rather than on life-cycle costing, has not therefore been sufficient to identify program initiatives that further transportation goals.

Where consistent evaluation has in fact been used, management of federal infrastructure programs has improved. The inventory and screening procedures in the highway bridge program, for instance, encourage comprehensive consideration of options for operational changes (such as load posting or traffic management), rehabilitation, or replacement that reconcile structural or functional limits on bridges nationwide with the effects of these limits on traffic. The development of the National Airspace System plan, based on projections of changes in the configuration of air traffic control services and the costs of making them, offered a sound national investment in modernizing the system. As a result, these programs have promoted projects with high rates of return.

Incentives to Users and Program Managers

Federal programs fail to provide broad incentives to infrastructure users and local project managers to seek efficient choices. Where fees are charged, the prices of infrastructure services are often heavily subsidized, and users are generally not required to pay for the costs they impose on systems. This inflates and distorts patterns of demand. Congestion, caused by subsidized general aviation fliers, and road damage from undercharged heavy trucks, result in calls for capital expansion and improvements of the infrastructure that would not be required if all users paid their way. Trust funds, principally for highways and aviation but also recently established for transit and waterways, provide about 40 percent of federal capital assistance, and the earmarking of revenue sources has encouraged local managers to defer projects awaiting future trust fund appropriation rather than promptly undertaking construction or rehabilitation according to users' needs. Provisions of the Highway Trust Fund have encouraged tighter expenditure controls than might have been instituted under federal general fund financing, but assured revenue sources from the trusts has encouraged independence in infrastructure agencies from state and local budget processes. This assured revenue also encouraged federal managers to add new programs without proper consideration of the continuing relevance of existing ones.

Moreover, at the state and local levels, studies in all infrastructure areas now fairly consistently find that 60 percent to 70 percent of federal aid fails to stimulate investment beyond the level that states and localities would have financed from their own resources. By and large, states and localities have become adept at converting categorical assistance into *de facto* block grants.

Further, state and local managers make use of municipal tax-free bonds to finance their projects. The federal subsidy conveyed through these instruments is tantamount to a "blank check", allowing local decisionmakers to deploy federal subsidies without regard to the project's conformity with national goals.

POLICY OPTIONS

The successes and lessons of program management that the Congressional Budget Office (CBO) has found suggest several opportunities to improve the effectiveness of federal infrastructure programs. These initiatives would complement ongoing efforts to improve information on budgets for capital spending (required under the Federal Capital Investment Information Act of 1984), and to provide annual reports on the condition and sufficiency of the infrastructure (required of the National Council on Public Works Improvements established by the Public Works Improvement Act of 1984). Two avenues of change appear particularly fruitful.

First, the Congress could require that, in supporting spending requests, federal agencies provide specific, budget-oriented information on the progress made toward each program's objectives, reviews of the efficacy of current practices in promoting infrastructure goals, and consistent information on the investment effects of diverse programs. These measures would change current reports to the Congress on infrastructure from reviews of current conditions and projections of future spending under different assumptions--status reports--to analyses demonstrating the outcomes of past spending and suggestions on management approaches to ultimate goals. The aim of such changes would be to draw agency executives most familiar with day-to-day management of programs more closely into monitoring them and proposing beneficial changes in management practices. These types of changes would draw federal agencies into planning to achieve goals in the sectors they manage and into both program and project evaluations. The Congress would be presented with more realistic estimates of current and future spending under each program, and with documentation on the effectiveness of different policies.

Second, changes in the conditions for providing federal subsidies or in the channels through which disbursements are made could aim to improve state and local project choices. These changes would not necessarily alter aggregate national spending on infrastructure, but they would alter the relative federal and state/local responsibilities for providing financing. Lowering federal spending or encouraging federal managers to negotiate cost shares with project sponsors would make infrastructure managers more reliant on funds from state and local budgets, drawing them more closely into those selection procedures. Devising sunset conditions for programs would revise expectations about the permanence of federal assistance in programs that are nearing their goals. Calculating aid on the basis of total life-cycle costs rather than on those of capital investment costs alone might help to avoid biases favoring investments over operational improvements. With pricing policies that aim at efficient use of facilities, users could be drawn more closely into project choices. Another way to achieve better state and local project choices is to reduce the separate categories of aid so that projects compete more equally for financing; this might be accomplished either by using block grants or by parceling out ("tranching") aid into preferential categories that promote preferred management practices in infrastructure agencies.

States and localities might resist federal efforts to monitor programs more closely, and federal agencies might be unwilling to make objective reviews of programs and policies. Reduced federal support might prompt states to ignore the "spillover" effects that federal intervention seeks to correct. Greater shares of state and local funding might also fall more heavily on less-affluent groups because of the more regressive structure of nonfederal tax systems. Certainly, major changes in the management of infrastructure would require carefully recasting current federal, state, and local relationships in infrastructure programs. But redefining these roles would be an essential first step in bringing federal management of infrastructure programs into line with the current focus on ensuring access in each region to whatever mix of public facilities and services best serves that region's economic and social goals.

CHAPTER I

MANAGING THE NATION'S INFRASTRUCTURE

The condition of the nation's public infrastructure is a major public policy concern. This concern is reflected in a wide variety of proposals. These include changing the level of federal resources or the federal role in public infrastructure investments, making inventories of public assets or of "needs," and altering the manner in which the federal budget records public sector investments.

In this study, the Congressional Budget Office (CBO) addresses these issues by examining the system used to identify, evaluate, and implement those infrastructure projects that are financed by the federal government. The long-term objective of such a system is to arrive at a level of public spending and a mix of projects that will result in an infrastructure adequate to support the nation's social activity and economic strength.

The federal government currently owns and operates relatively little of the nation's infrastructure. Much of its influence on infrastructure development is therefore exercised through its budget support for different programs and through its regulations on standards and requirements for infrastructure systems of national importance. Consequently, an *infrastructure management system* will have its most important effect through the budgeting process and will try to improve the budget choices made among infrastructure projects. In the public sector, however, this budgeting process has a number of unique aspects that need to be kept in mind in developing an effective infrastructure management system.

BUDGETING IN THE PUBLIC SECTOR

An infrastructure management system must systematically determine the amount and composition of government budgets. Budgetary choices reflect goals and means. A budget reconciles the objectives of individuals and organizations with the resources they have. Households try to further their wellbeing, and firms seek profits. Governments, however, seek broader goals--national welfare or equity--that are less easily measured or compared. Nonetheless, they pursue such goals in choosing among proposals for financing. These choices involve costs. What level of resources should each activity use? Which activities must be forgone? Matching resources and goals implies some consistent application of criteria, so that the mix of activities chosen consists of the best of the opportunities available.

The traditional model of budgeting in an organization begins by describing techniques for evaluating and ranking activities and projects in the order in which they can contribute to goals. The budget chosen then reflects whatever mix makes the greatest contribution that can be afforded. Any public sector infrastructure management system would be based on this model. But the system should also incorporate features that reflect the government's unique position.

First, governmental decisionmaking must be more comprehensive than that of families or firms. In pursuing any objective, households and corporations maximize their private returns or minimize their private costs. Governments, however, must consider costs and returns in a broader sense. A lower public cost is not always the same as a lower national cost. For example, lowering the cost of highways by reducing standards for the strength of highway pavement could lead to higher levels of road damage by heavy trucks, which in turn could raise costs for both motorists and state highway maintenance authorities by more than the amounts saved in construction costs. Similarly, national benefits are wider than any strict definition of government returns. In many infrastructure programs, returns to the government are found only in the broadening tax base of growing economic activity. But the cleaner air, swimmable water, safer navigation, or more efficient transport that result have clear national benefits. If infrastructure policy is to promote national goals for welfare and equity, then its effects on all sectors of society must be assessed and taken into account.

Second, the decisions must be consistent at both the program and project-selection levels. Federal managers are more often concerned with the size and scope of national programs (for example, Federal-Aid Highways) than with selecting individual projects. Federal decisions about the size of an overall program, its distribution among recipients, and the eligibility conditions for projects must provide state and local agencies the incentive to make project choices that reflect the program's goals, rather than strictly local preferences. Differences in outlook and responsiveness at different levels of government have to be factored into the process.

Third, in the public sector, the management system must be able to show the consequences of spending more or less than the proposed amount. The textbook model is usually one in which all budgetary choices are determined simultaneously. For administrative and practical reasons, however, budgetary processes frequently must choose first between similar types of activities, and then between sub-budgets for activity groups. Thus, while infrastructure budgeting deals with only part of the national budget, it is an important part, both because of the size of the investment program ($76 billion in public spending in 1985) and because of its major influence on economic and social activity.[1]

Lastly, any management system that tries to improve budgetary choices requires resources for preparing studies and reports, and for implementing decisions. Therefore, systems must also be administratively efficient and practicable. Moreover, because goals are broad, and because policy emphasis shifts from time to time, infrastructure management must also be able to respond to change.

EVOLVING FEDERAL GOALS IN INFRASTRUCTURE

Several goals have led to a significant federal role in the provision of public infrastructure. First has been the goal of development. The federal government has traditionally sought to use infrastructure as a basis for regional economic growth, particularly in instances where the returns to infrastructure investments were realized by the nation or community at large. Thus, in the nineteenth century, the goal of balanced regional growth underlay federal initiatives in national navigation and rail systems. A second motivation has been coordination, particularly when large projects required efforts in every region of the country. This goal led to federal support for construction of a national highway network earlier in this century, and subsequently the provision of a national air navigation system. A different type of coordination concerns "externalities"--that is, activities conducted in one area that have important effects on other areas; for example, the federal government subsidizes the construction of wastewater treatment facilities in some localities in order to prevent polluting discharges in others. A third motivation has been equity and concern for the social welfare of different groups. Western irrigation development, also dating from the early 1900s, was begun to preserve the nation's family farming tradition while also encouraging settlement in sparsely populated areas. All of these programs began with a strong orientation toward construction to ensure that the physical assets supporting economic and social development were in place (*Box 1 chronicles the federal role in the two largest areas of public works infrastructure, transportation and water systems*).

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[1] These data cover all government purchases of structures and durable equipment except those for military purposes.

BOX 1
MILESTONES IN FEDERAL PUBLIC WORKS MANAGEMENT

Navigation

1826	Army Corps of Engineers undertakes building and maintenance of waterways and harbors.
1827-1866	Federal land grants offered for canal development and navigation improvements.
1920-1940	Federal Barge Lines operated.
1981	Barge fuel taxes began being paid into the Inland Waterways Trust Fund.
1984	Corps begins to negotiate cost-sharing agreements for public purpose navigation projects.
1986	Customs levies dedicated to port maintenance.

Rail

1837-1871	Federal land grants made for railroads.
1890s	Federal regulation established for railroads.
1970	Amtrak established.
1974	Conrail established.
1980	Staggers Rail Act reduces federal rail regulation.
1986	Sale of Conrail proposed.

Power and Irrigation

1902	Bureau of Reclamation to build irrigation systems in western states.
1933	Tennessee Valley Authority to develop water resources in the South.
1965	Local cost-sharing for recreation components of multi-purpose projects begun.
1983	Corps proposes negotiated cost-sharing for public-purpose projects.

Highways

1916	Federal government offers 50 percent financing for construction of state and local road systems.
1956	Highway Trust Fund established to finance 90 percent of the construction of the Interstate Highway System from earmarked tax receipts.
1970	Bridge rehabilitation and replacement program initiated. Federal aid extended to urban arterial systems.
1972	First planned completion date set for the Interstate network. Special federal aid for urban areas includes major repairs.
1974	Reconstruction and resurfacing aid offered for non-Interstate systems. Federal share for state/local systems increased to 70 percent.
1976	Restoration, resurfacing, and rehabilitation aid offered for Interstates.
1978	Federal 75 percent share offered for non-Interstates.
1982	Highway taxes and highway programs increased by 44 percent. Reconstruction on interstates begun.

1966	Department of Transportation established to manage all transportation programs except navigation projects.
1984	Parts of Interstate system designated for oversize vehicles.
1990	The current planned completion date for Interstate network.

Aviation

1926	Federal regulation initiated to assure safe flying.
1938	Civilian air traffic control system established.
1946	Federal matching grants offered for airport construction and rehabilitation at 50 percent to 94 percent.
1958	Federal Aviation Act unifies civilian and military air traffic control.
1970	Airport and Airway Trust Fund established with earmarked aviation taxes.

Water Supply

1926	Farmers' Home Administration begins to develop water systems in rural areas.
1958	Corps of Engineers and Bureau of Reclamation adds water storages to ongoing projects.

Wastewater

1957	Federal grants of up to 30 percent of wastewater treatment plant construction costs made available.
1966	Federal government covers 50 percent of construction costs.
1972	Clean Water Act mandates secondary treatment of wastewater. Federal construction set at 75 percent of costs. Program goal to restore fishable and swimmable water by 1983 established.
1977	Management of federal aid to projects delegated to states. An 85 percent match for "innovative, alternative" technologies made available.
1981	Construction grants reduced to about one-third, and federal share reduced to 55 percent for projects after 1985. Goal for "fishable and swimmable" water deferred to 1988.

Mass Transit

1961	Limited federal assistance offered for transit demonstration projects.
1964	Capital grants made available for up to two-thirds of modernization project costs.
1970	Highway transit projects allowed to substitute for urban highway projects.
1973	Federal share increased to 80 percent. Transit projects allowed to substitute for Interstate segments withdrawn from the uncompleted network.
1975	Federal subsidies of up to 50 percent of operating losses offered to transit systems.
1982	Mass Transit Account in the Highway Trust Fund established from revenues from a one-cent-a-gallon tax on motor fuel.

The general level of maturity in the national infrastructure systems reached in about the late 1960s led to a broadening of federal interest that focused mainly on making qualitative improvements in the construction-oriented programs. More attention was paid to issues of pricing and cost sharing, and rehabilitation of existing systems. In addition, to improve efficiency, transportation services were substantially deregulated in the 1980s, and management of other programs devolved to states.

THE FEDERAL RESOURCES IN INFRASTRUCTURE FINANCING

Today, the nation's infrastructure systems are owned and operated by federal, state and local governments. Budget choices at all levels of government influence the conduct of infrastructure programs. The federal government's most important role in infrastructure provision, however, is as a source of finance. In fact, it provides over half of the nation's gross investment in infrastructure, yet determines only 20 percent of the actual infrastructure project choices (see Figure 1).

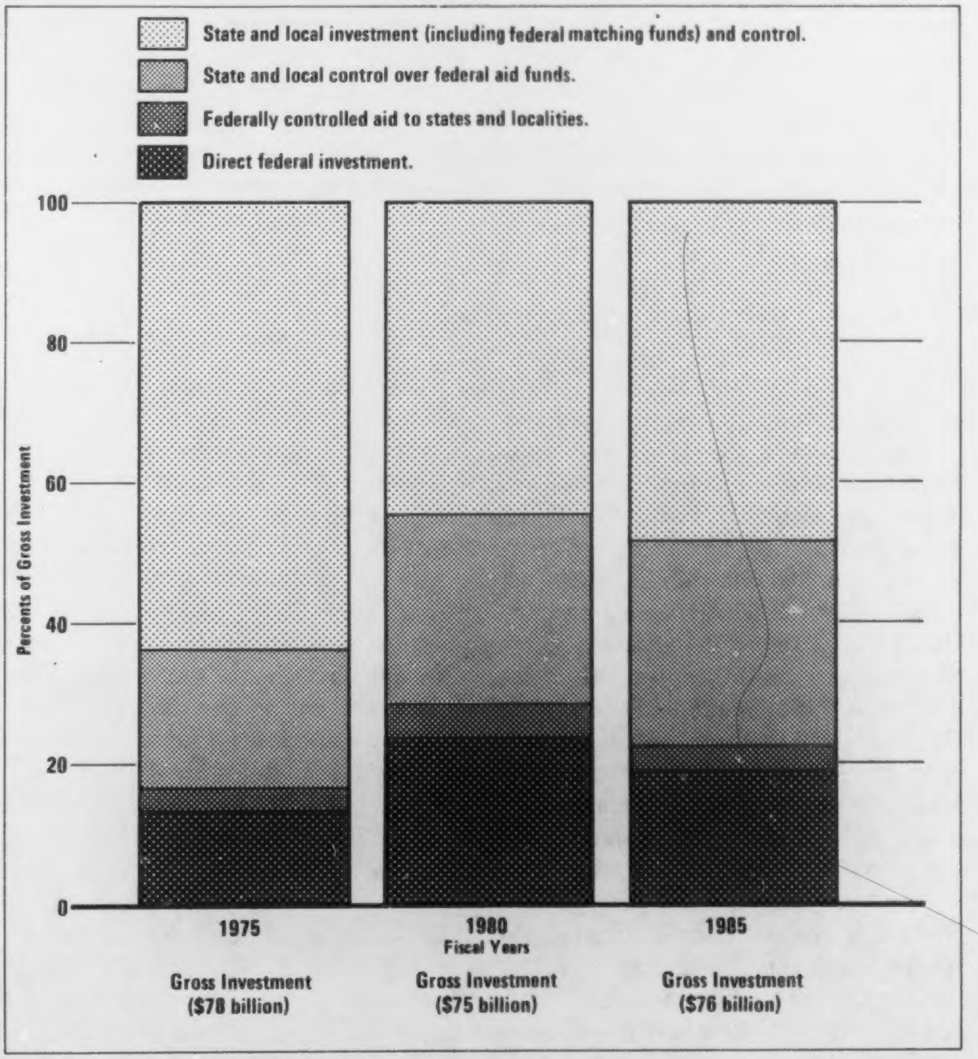
Federal funding for infrastructure occurs through a variety of mechanisms, including cost-sharing programs, block grants, or tax-free municipal financing. In most cases, the federal government's role is usually custodial. In exchange for funding assistance, its agencies oversee state, local, or regional governments' conformity with eligibility requirements or performance tests. Highways, airports, and wastewater treatment facilities are all constructed and operated under this arrangement.

In other programs, such as water projects constructed by the Corps of Engineers or new urban rail starts supervised by the Urban Mass Transportation Administration, the federal government acts directly, as either the project director or project approver. In these cases, federal management policies are used to choose among different project options. Once these assets are built, however, their management and operation commonly devolves to state or local authorities, whether ownership remains with federal agencies (as is generally the case with water resources developments) or whether it falls to nonfederal agencies, as under discretionary or demonstration projects approved individually by federal agencies but funded by federal capital grants.

Finally, in very few instances, typically only in the case of locks and dams for inland navigation, does the federal proprietary interest cover both the provision and operation of infrastructure systems.

Figure 1.

Federal and Nonfederal Financing and Control of Infrastructure Spending: 1975, 1980, and 1985
(In percents, based on gross investment in 1982 dollars)



SOURCE: Congressional Budget Office based on data provided by the Office of Management and Budget and the Bureau of Economic Analysis.

An important federal influence is therefore as overall "coordinator" of the nation's infrastructure. While the states, for example, select road segments to be built, the federal government coordinates those selections into the nation's Federal-Aid Highway Program, using its cost-sharing policy to induce the states to integrate their selections with the rest of the national system. As a promulgator of regulations, as in the cases of highway design or wastewater treatment, the federal government determines the minimum quality of acceptable infrastructure. It also collects large amounts of data in support of this coordination role. For example, a biennial inspection system for the nation's bridges provides virtually complete information on their physical condition; annual statistical reports from transit agencies offer comprehensive data on their operating and financial performance.

CURRENT PROPOSALS FOR CHANGE

Current federal policies for infrastructure provision is under pressure to change. Many proposals seek to increase the amount of information available to the Congress and to federal program managers regarding the condition of the nation's infrastructure facilities and the level of spending dedicated to them. The Public Works Improvement Act of 1984 established a National Council on Public Works Improvement and instructed it to report annually on the nation's infrastructure--its age and condition, its maintenance and financing needs, and its capacity to sustain growth. A second title to the same bill requires that the President's budget submission identify and project public capital investment levels; this identification has been done in a Supplement to Special Analysis D submitted to the Congress by the Office of Management and Budget. Others have proposed that the Congress should adopt a "capital budget," like that often used by state governments, which would segregate expenditures going to capital improvements from other operating expenditures. *(Box 2 discusses the usefulness of "needs estimates" and "capital budgeting" in infrastructure management.)*

The information gathered by these devices would be of geniune interest to the Congress. But the information itself does not advise decisionmakers what to do about the situations it describes. Inventories or "needs surveys" describe condition. Knowing that a certain percentage of roadways are in poor shape, however, does not inform decisionmakers whether those roads should be resurfaced, minimally repaired, or, in light of very low traffic, perhaps not repaired at all. Similarly, having a capital budget suggests that capital projects are the only recognizable means of solving infrastructure deficiencies. But operating rules, pricing policies, and other "nonstructural" alternatives may be just as effective, for example, auctioning off peak-time landing rights may reduce airport congestion as much as building new runways.

Given the main federal role as a financier of infrastructure investment, it is also unclear that a federal "capital budget" would be effective in identifying infrastructure spending. Federal "capital" grants transfer resources to states and localities that invest in facilities; in many direct programs, ownership or operating authority of assets is transferred to local agencies on completion of construction. Federal capital accounting might therefore be inappropriate for infrastructure programs, where federal cost-sharing and block grants influence greatly infrastructure choices, but few federal assets exist.

A second class of proposal concerns changing the level of federal effort. Several, like H.R. 1776, and H.R. 2818, would increase resources available for infrastructure investments by subsidizing the establishment of revolving loan funds. Others, like the Administration's proposed fiscal year 1987 budget, would reduce federal involvement. Proposals that would expand the scope of the federal government's efforts, or increase the funding of existing efforts, are motivated by the perception that infrastructure spending is not keeping facilities in good working order. A previous CBO report, as well as the OMB special analyses, however, suggest that existing program spending levels could provide adequate infrastructure investments if accompanied by program changes.[2] Moreover, total public investment since 1950 has been more than sufficient to offset depreciation of public assets and build a growing capital stock. In fact, major increases in spending in 1984 and 1985 have largely redressed the long-term decline in annual spending since 1968, and have restored growth in the nation's net additions to its investments in public facilities (see Figure 2).

A MODEL FOR AN INFRASTRUCTURE MANAGEMENT SYSTEM

These pressures for change raise basic questions. Are we spending enough on public infrastructure? Are we concentrating our spending on the right projects? Most simply, the existing system for managing public infrastructure provides us with no way of knowing. "Enough" infrastructure will have been provided when every project that is economic--in other words, that delivers benefits in excess of its costs when both are correctly measured--is implemented. The sufficiency of the nation's infrastructure cannot be measured in the aggregate; "sufficiency" is measured by the characteristics of the projects undertaken. The key to investing in the "right" infrastructure, therefore, lies in developing a system that recognizes the diverse possibilities for satisfying the demands for infrastructure services, evaluates them realistically, and implements the best available options. Such a system must cope with the different federal roles in infrastructure. When federal programs provide and operate the facilities, management requires consistent ways to identify and select improvements; in grant programs, federal financing and regulatory policies must set incentives for

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[2] Congressional Budget Office, *Public Works Infrastructure: Policy Considerations for the 1980s* (April 1983), and Office of Management and Budget, *Supplement to Special Analysis D, A Report Required by the Federal Capital Investment Program Information Act of 1984 (Title II of Public Law 98-501)*, Washington, D.C. (February 1986).

BOX 2
CURRENT INFRASTRUCTURE MANAGEMENT CONCEPTS--NEEDS ESTIMATES AND CAPITAL BUDGETING

Two planning tools recently considered--needs estimates and capital budgeting--would list infrastructure projects bidding for financing, identify amounts and sources of finance under current policies, and calculate the gap between the two. Yet neither provides a truly broad-based system for comparing options within and among programs. Both concepts rely on a static view of how systems suit community activities and a narrow view of the options available to improve services.

Needs estimating typically starts with a list of physical flaws or lacks measured against some technical standard. Then, to determine whether funding is adequate, a price list of remedies is totaled and compared against projected program levels.

For managers, this approach raises problems in making budgetary choices. First, remedies not requiring capital spending can often be found. And some deficiencies may not be worth fixing. Second, looking for solutions across a wide range of professional disciplines, even in an "engineering" project such as maintenance, usually pays off in productive innovations. Moreover, national or statewide needs estimates must be based on broad concepts or designs so that capital solutions can represent only the most preliminary estimates. The design and cost of any project seriously contending for approval can vary widely according to local conditions.

Finally, budgeting from needs lists cannot lead to informed choices among projects and across programs. Differences between present and future effects, between different programs, between difstate or local managers to make appropriate infrastructure choices; and in the middle ground, federal collaboration with other governments in planning or operating infrastructure systems must reinforce choices that further national goals.

The Infrastructure Management System

To build the "right" infrastructure, an infrastructure management system must accomplish three important objectives:

ferent problems, and between localities may all be overlooked. Nor are priorities ranked in any order. Furthermore, needs estimates fail to measure benefits, usually assuming that meeting engineering standards is objective enough.

Capital budgeting is a process that, in most U.S. public-sector contexts, separates proposals for investment from those for recurrent spending. As with trust funds, the aim is often to insulate capital proposals from general budgetary constraints.

In planning, however, capital budgets fail to recognize complementarities between investment and operating policies. Investment projects cannot be evaluated apart from their effects on the costs and efficiency of ongoing operations. The infrastructure budget needed includes a combination of current and capital projects, selection of which cannot reasonably be separated. Whether any infrastructure aim is better achieved through capital or operating aid should be influenced by what yields good services at low cost.

Capital budgets often suggest separate consideration not only of spending proposals but also of sources of financing for recurrent and capital projects. They are often used to evade budgetary constraints. They do so by earmarking tax revenues for current programs and debt financing or dedicated user fees for investments. Such resource divisions create the same restrictions as separating project consideration. Investments that provide significant savings in operating costs may find greater difficulty in attracting user support than can investments that enhance service quality. Incentives to improve efficiency for the wider benefit of the community served may be disregarded in favor of the interests of users.

- Identifying all the available options,
- Evaluating them correctly, and
- Implementing the choices.

These three activities fit together to form a system that can help guide budgetary choices toward providing the "right" infrastructure investments.

Identifying Options

The first and perhaps most important goal of an infrastructure management system is to identify all possible ways of reaching objectives. Projects to improve or expand infrastructure are almost always alternatives to or complements of other actions directed toward similar goals. Investments in new infrastructure projects can lower costs or improve productivity, just as changes in operating procedures can. The wide choices available are perhaps most immediately obvious in infrastructure programs for newly

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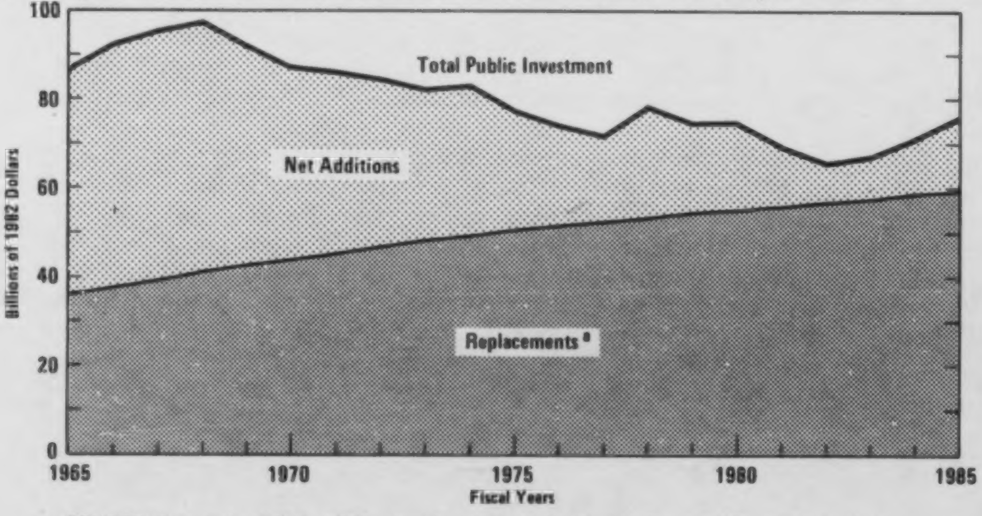
Figure 2.

Profile of Public Investment in Public Works Assets from 1965 through 1985: Total Investment, Net Additions, and Replacements



SOURCE: Congressional Budget Office based on data provided by the Bureau of Economic Analysis.

[a] Replacement data reflection depreciation of existing capital stock.

developing areas. Here, providing infrastructure according to preset standards, setting new standards, or intervening directly to modify demands through zoning or land-use controls are clear alternatives.

Noninvestment choices and options for alternative investments are equally relevant in planning for investment in older systems. Relieving congestion, for example, can be achieved by providing new facilities, improving those that exist, or manipulating demand for service through prices. Thus, the ultimate quality of infrastructure services is directly related to the ability of infrastructure managers to identify and consider the broadest possible range of solutions to infrastructure problems.

Evaluating Options

Once a broad range of options is identified, a management system must evaluate them logically and consistently. An efficient system for providing infrastructure requires that consistent choices be made between investment and operating solutions, between options imposing diverse good and bad effects on different groups, and between options bearing results later rather than sooner. Evaluations necessary for such choices have two essential features:

- A life-cycle approach measuring costs and benefits over the life of assets in capital options, and

- The use of comparable measures of worth that can span differences in technology among options and differences in the timing of such events as maintenance and renewal cycles.

A final step in the evaluation process is to rank the choices in order of merit. Ranking options assures that projects selected of the highest worth are for the budget program. Similar techniques to those comparing diverse effects of project choices can be applied in ranking projects under a range of programs.

Implementing Choices

An infrastructure management system must incorporate the preferences of local users into program objectives and, at the same time, help induce localities to make choices consistent with national aims. For the most part, federal agencies provide funds for projects selected largely by others; they do not make the project choices. When federal discretion over projects is exercised, it usually favors choices with strong local backing.

Federal infrastructure management, therefore, must organize federal financing in ways that will lead users and local infrastructure agencies to make choices consistent with federal goals. Pricing systems that reflect the costs users impose on infrastructure can encourage marketlike forces to ration use, so that demand patterns reveal users' preferences. Subsidies for certain types of infrastructure development encourage their provision at the expense of less preferred categories of spending. Federal practices relating to infrastructure pricing and the provision of financial assistance thus strongly influence the outcome of the programs.

CHAPTER II

IDENTIFYING INFRASTRUCTURE PROJECT OPTIONS

The first goal of a systematic approach to managing infrastructure is to identify the broadest possible range of projects to realize federal policy goals. The greater the range of possible solutions considered, the better the likelihood that the best solution will be chosen. This chapter examines how arbitrary restrictions on the search for solutions have so far impeded the effectiveness of federal programs.

LIMITS ON SEARCHES FOR SOLUTIONS

Searches must have limits, of course. Protracted searches for possible courses of action can lead to expensive administrative and technical studies that do not improve the quality of decisions. As a practical matter, therefore, sound agency management will tend to limit searches for options, given scarce administrative resources. But other types of limits are likely to work against effectively implementing the policies that infrastructure programs pursue.

In fact, federal policies do not consistently encourage broad searches for ways to improve the productivity of infrastructure systems. Most federal programs are managed not to support and promote broad policy goals but instead to provide capital for predetermined types of projects. Though these projects were generally chosen to promote broader goals, the criteria and standards for completing the projects themselves, rather than their effects on community well-being, have tended to become the focus of management. For example, careful attention is paid to engineering standards for roads, while little is paid to the effects of road improvements on transportation efficiency. How, then, can the search for solutions be expanded?

First, identifying options for improving infrastructure systems and services must focus on the goals to be served, rather than on finding ways to improve or expand existing facilities. Clean water and urban mobility, for example, are objectives; constructing wastewater treatment plants and modernizing bus fleets are merely two possible actions for furthering those goals. Limiting project choices to expansions or improvements of existing facilities obscures the potential gains that may be available from better management (imposing standards for wastewater discharges, for example, or reorganizing bus schedules) or from productivity gains (perhaps from improved maintenance or labor training). Limiting options considered to those improving physical facilities risks ignoring large potential improvements from changes in operating practices that raise the quality of services provided. These are just as important to a program's overall success as is expanding existing facilities. (*Box 3 illustrates one approach to a broad search for improvement options.*)

Second, limiting infrastructure options to those under the control of a particular agency or jurisdiction runs the risk that the agency's aims, rather than national objectives, will be furthered. Ways to improve commuter services, for example, include new subway systems, dedicated lanes for high-occupancy vehicles, and changes in downtown parking regulations and prices. But restricting choices just to those for increasing mass transit services risks a chance that the most efficient or least-costly way of improving an urban transport network as a whole will be overlooked, or at best, that transit services will be improved with little reduction in overall commuting costs. Questions of authority or eligibility are thus best left until after the most appropriate plan of action has been determined.

A third problem concerns timing. By limiting options to those involving capital improvement or to those under the control of designated managers, decisionmakers can lose sight of the operational nature of infrastructure systems and of the long lives of structures and equipment. Building later is an alternative to building now, just as postponing investment and managing demands through pricing is an alternative to building at all. Infrastructure systems deal mostly with gradually rising user demands over the life of established facilities. *When* to expand is as important a consideration as *whether* to expand. Considering the effects of infrastructure options over the useful lives of facilities is critical to sound program management. Different actions can be effective over different time spans, and the most efficient long-term solutions may include a mix of operation rules and investment projects. Searches for options must consider choices not as "either/or" matters but as potential parts of combinations of complementary actions.

The remainder of this chapter looks at two features of current federal infrastructure management that have influenced the scope of searches for ways to improve services:

- **The choice between design specifications and performance standards for meeting program goals.** Federal programs differ widely on this score. But in two programs in which managerial emphasis

BOX 3

IDENTIFYING A BROAD RANGE OF OPTIONS-- VALUE ANALYSIS FOR LONDON TRANSPORT-RAIL

London Transport-Rail, responsible for London's underground rail system, uses Value Analysis to search broadly for proposals that would improve maintenance productivity and to meet annual targets for reducing maintenance costs. The procedure relies on decentralized suggestions subject to central, standard review to find ways of lowering costs and/or improving effectiveness. Any staff member may suggest a new technology, equipment change, organizational change, incentive scheme, production technique, or procedural revision. The different technical backgrounds and experience of the engineers, finance officers, and managers responsible for maintenance generate diverse operational, investment, and tactical proposals.

Before final selection, review of the proposals includes preliminary screening for the more promising options. All parts of the organization affected by any option suggested participate in the screening, and anyone may propose either modifications to the suggested change or a new option for achieving a similar result. Options selected for final review are subjected to rigorous cost and technical study, but the final proposal presented to management with recommendations includes an overview of all options, including a summary of those put aside at the preliminary screening. Thus, no option is finally discarded until deemed clearly inferior by final decisionmakers.

London Transport has found advantages in this wide approach. Engineering and financial planning functions have become much more closely integrated with line operations. The better understanding between the disciplines involved and the coordinated approach to working through the effect of suggested actions on operations has increased the likelihood that beneficial changes in standard operating procedures, staffing levels, and job responsibilities will be approved.

SOURCE: For more on this subject, see Douglas W. Carter, Jeffrey E. Purdy, and William R. Steinmetz, *Getting Control Over Operating Budgets: A Methodology for Evaluating Productivity Alternatives* (Washington, D.C.: Transportation Research Board, January 1985).

has switched from project design specifications to actual project performance--pollution abatement and transit for the disabled--the use of performance targets has allowed consideration of wide ranges of options. As a result, managers using performance standards have been able to achieve program goals faster, more efficiently, or at lower cost than under technology-based specifications.

- **The limits on eligibility for federal aid to certain types of project.** A look at how localities have substituted their preferred projects for uncompleted segments of the Interstate Highway System shows that, when programs cover a wider range of eligible projects, a better mix of projects is likely to result.

DESIGN STANDARDS *VERSUS* PERFORMANCE STANDARDS

Perhaps because of the relative ease of monitoring or verifying compliance with physical standards, or perhaps more simply because federal programs have emphasized assistance for physical facilities, management in many infrastructure programs has tended to concentrate on physical data, particularly on unfinished elements. How many miles of highway, or how many wastewater treatment plants, have yet to be built? The condition of these facilities then dominates decisionmaking. How high are the infiltration and seepage rates of sewer and water systems? How many miles of pavement are in poor condition? How old are the transit bus fleets? At the same time, program efficiency is often measured in terms of minimizing costs, leading to such techniques as "value engineering" (a system for finding the least-cost method for implementing a specific design), or to an emphasis on improving construction management. Tactical choices are also scrutinized as possible cost reducing measures. Modernizing the Coast Guard's fleet, for example, has been deferred pending a review of the cost effectiveness of hiring contractors to inspect navigation aids. The Federal Aviation Administration used contractors to reopen 12 air traffic control towers closed during the 1981 controllers' strike, and overall it plans to convert the towers at 55 low-activity airports to contract operation.

All these techniques reduce federal costs. But they all assume some fixed specification for the facilities to be built or the activity to be undertaken. Assessing the advantages of choices that do not meet the pre-set physical standards, even if equally effective in meeting goals or more so, can be done only clumsily under these management approaches.

Realizing this difficulty, some programs are monitored against performance targets reflecting program goals, instead of against design standards. Several have switched between using specifications and applying performance standards or targets as goals for action. A review of these examples shows that when performance is the focus program efficiency is more likely to improve.

Using Performance Targets: The Case of Pollution Abatement

When the Water Pollution Control Act of 1972 (Public Law 92-500) mandated goals for achieving fishable and swimmable water by 1983 (since extended to 1988), and established a program of federal construction grants for secondary wastewater treatment plants to assist in achieving this goal, the Environmental Protection Agency (EPA) issued regulations for meeting minimum federal standards for treatment.[1] These regulations required virtually every community to construct a chemical treatment plant. The law has since evolved. First, in 1977, amendments provided for the delegation of water quality program management from the EPA to the states. Also, the focus changed to favor "best practicable" technologies.[2] New incentives encouraged the use of innovative, less costly alternatives to chemical treatment (including oxidation ponds, lagoons, and ditches, trickling filters, and ocean discharges) when these led to water quality equivalent to that achieved by chemical treatment. Pollution abatement policy for treating industrial wastewater has similarly broadened to allow cheaper techniques that can meet water quality standards.

In the case of water treatment, using "best practicable" technology has lowered treatment costs without impeding water quality goals. Use of advanced design and innovative treatment techniques has been found to offer cost savings of half those required by technologies approved by the EPA.[3] By 1981, treatment systems were removing 65 percent more of critical pollutants than in 1973.[4]

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[1] EPA regulations (40 CFR 133.102).

[2] Public Law 95-217 offered an extra 10 percent, or an 85 percent federal grant, for innovative or alternative secondary treatment technologies. Public Law 97-117 subsequently reduced the federal match for innovative technologies to 75 percent, and the match for other treatment plants to 55 percent in 1985.

[3] See Congressional Budget Office, *Efficient Investment in Wastewater Treatment Plants* (June 1985).

[4] House Report 97-270.

In air pollution abatement programs, however, the reverse occurred. In 1978 amendments to the 1970 Clean Air Act, minimum treatment standards were added to maximum emissions targets for new electric power plants.[5] Plants burning coal were no longer permitted to meet national standards by using low-sulfur coal; instead, all new plants were obliged to install flue gas desulfurization equipment (called "scrubbers") to remove between 70 percent and 90 percent of all potential sulfur dioxide emissions. Nationwide, these changes have been estimated to have increased utilities' long-term costs for air pollution abatement from below 7 percent of capital expenditures to around 20 percent. From the consumers' perspective, these costs have been significant. The mandatory use of scrubbers is estimated (taking account of operational costs and adjustments in coal sources) to have increased electricity rates for new power plants by as much as 10 percent.

A cleaner environment is of real economic value. But according to some analysts, the investments in scrubbers have produced a much lower net benefit than the emmision limits in force during the 1970s. Studies using methods developed by the National Academy of Sciences for estimating the value of health benefits, for example, conclude that the emission reductions following from the 1970 Clean Air Act have provided long-term improvements in health that, by themselves, would outweigh the costs of achieving them. But applying the same estimating technique to the 1978 technology standards shows that investments in scrubbers are likely to have had negative returns over cost.[6]

Using Performance Targets: The Case of Mobility For the Handicapped

How management approaches have evolved in the federal program for making public transit available to handicapped people illustrates the problems of adopting a design-oriented approach. At the same time, it also demonstrates some of the reasons such approaches are taken.

Despite the clear policy statement in 1973 that a handicap should not exclude anyone from participating in or benefitting from programs financed with federal assistance, and despite Department of Transportation (DOT) guidelines of 1976 emphasizing "special efforts" to meet this goal in transit, no widespread moves were made to improve access where it was limited.[7]

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[5] This section of the report is based on Congressional Budget Office, *The Clean Air Act, the Electric Utilities, and the Coal Market* (April 1982).

[6] See Lewis J. Perl and Frederick C. Dunbar, *Cost Effectiveness and Cost-Benefit Analysis of Air Quality Regulations,* The American Economic Review, vol. 72, no. 2 (May 1982).

[7] Rehabilitation Act of 1973 (Public Law 93-112).

A 1977 survey, for example, revealed that about 5 million people (or one-fifth of all counted handicapped people in the United States) were still unable to use public transit services, or could use them only with difficulty.[8]

In response to this inaction, DOT adopted a set of facility standards for transit operators in 1979.[9] The standards mandated that, within varying time frames, key subway stations be equipped with elevators, that at least one car per train be adapted to accommodate wheelchairs, and that all new transit buses be equipped with lifts. Pending installation of these facility changes, transit agencies were to provide temporary services in either taxis or refitted buses or taxis. Though wholly oriented toward facilities, this mandate translated the policy objective of excluding no one into a manageable project, and began progress toward achieving that goal. *(A different approach to compensating for disabilities that limit personal mobility is recounted in Box 4.)*

The expense of complying with the DOT standards to improve mobility for the disabled prompted a wider search for an appropriate mix of transit facilities and special services that would also further the policy aim. During 1980 and 1981, four variations on DOT's regulation were proposed, each allowing different combinations of the capital improvements mandated and other arrangements. Costs for the proposals ranged from roughly $44 per ride (for implementing DOT's initial mandates) to $4.50 per ride (for subsidized taxi rides).[10] The proposals also showed wide differences in the quality of services. Some, for example, imposed advance request times or required preregistration for use; others restricted trip purposes and limited hours of service, trip durations, or numbers of trips each rider could request.

The federal program now in force gives communities flexibility to provide capital improvements or to develop special services that demon-

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[8] See U.S. Department of Transportation, *Technical Report of the National Survey of Transportation Handicapped People* (October 1978).

[9] Federal Register, vol. 44, no. 106, May 31, 1979. Some flexibility was granted to localities through the Appropriations Act of 1981 (Public Law 96-400).

[10] Statement of Alice M. Rivlin, Director, Congressional Budget Office, before the Subcommittee on Housing and Urban Affairs of the Senate Committee on Banking, Housing and Urban Affairs, May 20, 1981. Dollar amounts are in 1981 prices.

BOX 4
SEARCHING BROADLY FOR SOLUTIONS-- MOBILITY FOR THE HANDICAPPED IN BRITAIN

In January, 1976, the British government introduced a noncontributory cash benefit payable to eligible disabled adults and children to help defray their transportation costs. The allowance replaced a system of providing vehicles to those handicapped persons able to drive. The old system had been criticized because it excluded the most severely disabled who were unable to control a car, and because the vehicle supplied to civilians--motorized tricycles--were inconvenient and unsafe. The mobility allowance adopted was preferred to a more expensive alternative that would have widened the vehicle program by issuing automobiles to all eligible disabled people.

The cash allowance granted (initially, five pounds a week) was not limited to reimbursement for transportation costs. Nonetheless, a survey of recipients in 1977 showed that the majority kept the amount separate from other household income and spent it on transportation. For households with cars, the allowance was most commonly spent on fuel and maintenance; households without cars spent it on taxis. At its initial rate, the allowance covered 35 percent of weekly transport costs of adult recipients and 42 percent for children, though its coverage was much higher for households without cars, for which it supplied 69 percent and 80 percent of weekly trips respectively.

In 1978, the current "Motability Scheme" was introduced. This allows recipients to put mobility allowances toward car rentals or lease-purchase installments for vehicle purchases negotiated through an independent charitable organization supported by auto manufacturers and financiers. In leasing or purchasing cars, a recipient assigns his or her mobility allowance payments for three to four and a half years to Motability, and makes cash payment of the difference between the sum of these amounts and the car's lease or purchase value. Mobility allowances cover all payments for the smallest car available; these cover maintenance and up to 10,000 miles of travel a year. Drivers must pay to adapt the car, but simple kits costing less than 100 pounds can be installed at neighborhood garages. (In 1981, the purchase scheme was extended to approved secondhand cars.) Allowance recipients are exempted from road taxes, and they pay lower property taxes for garages, carports, or land used for parking. They also enjoy extensive parking privileges.

SOURCES: For further information, see Kenneth R. Cooke and Frances M. Staden, *The Impact Of the Mobility Allowance, An Evaluative Study* (London: Her Majesty's Stationery Office, 1981), and *Door to Door, A Guide to Transport for Disabled People* (London: Department of Transport, April 1982).

strate special efforts to improve mobility where it is inadequate.[11] Costs are to be compared with service levels. But the standards DOT prescribed in 1979 were designed to make transit systems accessible to all handicapped people, not just most. As a result, DOT's rules were written to ensure access for the most severely disabled riders, although minor modifications to existing systems--lower steps, handrails, priority seats, smoother acceleration--would have given access to 80 percent of those unable to use transit services.

In establishing facility standards according to the needs of the most severely disabled, the 1979 regulations narrowed the debate on achieving the policy aim to options serving this group. Federally acceptable levels of funding that demonstrate special efforts for providing accessible transit services follow from estimated national amounts needed to provide adequate service levels for the most acutely disabled. In any given community, the resources needed for special groups will vary around this average. In addition, the minor modifications that would grant access to existing transit systems to the majority of disabled people must now compete for funding with the special requirements of a relative minority. While a wider range of choices can now be considered for alleviating severe handicaps, spending may not be sufficient to make transit accessible to all disabled people.

ELIGIBILITY LIMITS

A second type of arbitrary limit on the range of possible solutions concerns eligibility for federal aid. Some programs have encouraged wider searches by allowing wider ranges of options to be eligible for aid. To encourage local managers to write off unconstructed segments of the Interstate Highway System that local jurisdictions do not need, for example, federal rules were changed to allow officials to apply the equivalent federal aid to projects that improved urban transportation. Substituting highway transit for highway projects was first allowed by the Federal Aid Highway Act of 1970 (Public Law 91-605), which also introduced federal aid for urban arterial roads not on other classified systems. Changes made in 1973 permitted transfers between urban Interstate construction and mass transit aid. Reviewing the "swaps" made since 1980 shows that choices of Interstate construction projects to be undertaken are now better aligned with traffic needs.

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[11] DOT's final rule requires recipients of federal transit aid to develop a program for transit services for handicapped people. The program may combine special services and facility changes, but must meet six service criteria subject to an upper limit on its cost set at 3 percent of the transit agency's operations. DOT also proposes to develop rules for commuter rail services. See Department of Transportation, Nondiscrimination on the Basis of a Handicap in Financial Assistance Programs; Final and Proposed Rules, Federal Register Part II, Friday, May 23, 1986.

Broadening Federal Aid: The Example of the Interstate Highway System

Recipient cities may reallocate federal funds for the Interstate Highway System in two ways. First, they may transfer the monies available for segments that would complete the Interstate system from these segments to projects that improve mass transit or, since 1976, other federally aided highways. Second, they may substitute projects to improve road-based transit facilities (such as bus lanes) for assistance in improving urban roads. The cities themselves nominate the transfers and substitutes; beyond that, rules for such transfers vary. Exchanges favoring highway transit projects carry only the requirement that the substitute project offer transportation capacity equivalent to that of the project cancelled.

The DOT approves withdrawals from the Interstate network so long as it considers the project to be cancelled neither essential to the Interstate system nor important to local traffic, and so long as the recipient jurisdiction has devised what DOT finds to be a reasonable alternative plan. 12/ Local and state authorities must also agree that the Interstate project is not significant for local purposes, and substitute transit projects must be jointly prepared under the Urban Mass Transportation Administration's (UMTA) alternatives analysis procedure.

Thus, the two-decade-old program that once focused solely on transit has been broadened to encompass several facets of urban transportation systems. Program changes now encourage cities to seek improved local mobility with a mix of transit fleet modernization and general roadworks. Moreover, federal aid programs now permit cities to set priorities among programs that benefit long-distance and local traffic.

These wider choices allow localities to reappraise their infrastructure priorities. By the end of the 1970s, the average cost per mile of uncom-

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12. The Department of Transportation has published determinations of significance for all uncompleted segments of the Interstate network in 1977. Report of the Secretary of Transportation to the United States Congress, *Interstate Gap Study, 1977.*

pleted sections of the interstate network was some five times the overall average cost for the system as a whole (after correcting for inflation since the 1950s). The portions of the Interstate network still unbuilt today are the most expensive sections to construct. The withdrawal process therefore, provides a means of reassessing whether these expensive road sections should still be given priority over other undertakings.

A Model for Project Selection. An analysis presented to the Congress in March 1983 gives a model for assessing how withdrawals of Interstate projects have changed priorities for Interstate construction projects.[13] The Congressional Budget Office (CBO) has adapted that analysis to separate those Interstate segments traded in since 1980 from the remaining gaps in the system. (CBO has also changed the ranking system from a form of benefit/cost ratio used in the original analysis to a measure of return on investment.) (*Table 1 shows the results of CBO's update.*) Segments classified as "overdue" are those on which the first-year return following immediate construction is estimated to exceed greatly the borrowing cost of capital needed; those "due now" provide first year returns of around the cost of providing finance; and those "due later" are estimated to have such low returns as to fail to cover borrowing costs. Within these categories, subgroups show the broad timing at which--allowing for construction of contiguous road sections and for traffic growth--road construction could be economically justified. Thus, in shares of construction cost, 31 percent of all the gaps that existed in 1980 would have justified construction in 1970 or earlier, and thus were overdue by more than 10 years, while only 9 percent of the gaps that cities elected to withdraw appeared comparably overdue. Benefit measures, however, reflect only savings to highway users, so the results reflect only the priorities based on traffic needs.[14]

This review indicates that, at least on the highway side, the withdrawals seem to have induced cities to trade in Interstate segments for which there was relatively little anticipated traffic need. In dollar terms, 71 percent of the Interstate gaps withdrawn since 1980 would have been poor investments, with zero or negative returns judged on transport per-

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13. Skrotzki Associates, "Economics of Completing the Interstate Highway System," submitted for the record by Senator Armstrong on March 21, 1983. This analysis presented estimates of the benefits to users and costs of completing each remaining unconstructed gap in the interstate network.

14. For any particular link, for example, some nontraffic feature, such as, say, the disruption of large scale demolition needed in an urban area may outweigh traffic needs in decisions to postpone construction. For the network overall, however, traffic requirements are a reasonable representation of priority.

TABLE 1. INVESTMENT PRIORITIES FOR GAPS IN THE INTERSTATE HIGHWAY SYSTEM

	Priority Based on Traffic Cost Savings					
	Construction Overdue a/			Construction Due Later a/		
	More Than 10 Years	5 to 10 Years	Construction Due Now a/	In 1990s	After 2000	Total
All Gaps in 1980						
Number	53	14	20	11	69	167
Construction Cost (In billions)	7.6	1.9	3.4	1.1	10.7	24.7
Benefit/Cost Ratio	1.2-7.9	1.0-1.7	0.8-1.3	0.7-0.8	0.0-0.6	0.0-7.2
Internal Return (In percents)	12-80	10-16	9-12	5-7	-20-4	-20-80
Percent of Cost	31	8	14	4	43	100
Gaps Withdrawn Since 1980						
Number	5	3	4	1	6	19
Construction Cost (In billions)	0.3	0.2	0.5	b/	2.6	3.7
Benefit/Cost Ratio	2.5-5.1	1.2-1.6	0.9	0.8	-0.3-0.2	-0.3-5.1
Internal Return (In percents)	25-50	12-16	9	7	-17-0	-17-50
Percent of Cost	9	6	13	1	71	100
Remaining Gaps						
Number	48	11	16	10	63	148
Construction Cost (In billions)	7.2	1.7	3.0	1.0	8.0	21.0
Benefit/Cost Ratio	1.2-7.9	1.0-1.7	0.8-1.3	0.7-0.8	0.0-0.6	0.0-7.2
Internal Return (In percents)	12-80	10-76	9-12	5-7	-20-4	-20-80
Percent of Cost	35	8	14	5	38	100

SOURCE: Congressional Budget Office adapted from Skrotzki Associates.

NOTE: Dollars in billions in 1979 prices: benefit/cost ratio is the ratio of discounted benefits to discounted costs assuming 1980 construction; the internal return is the discount-rate which would equate the present value of costs and benefits over a 20 year life of the road segment; it represents the return on the investment. Date of construction priority is based on the year in which benefits would first cover annualized construction cost.

a. See text for definition.
b. Less than $50 million.

formance alone, compared with 43 percent of all gaps. In other words, the process of selecting candidates for withdrawal has sharpened the choices of which roads to complete to favor those roads with high traffic need.

But the withdrawals also include 28 percent, in dollar terms, for which traffic might have been expected to justify construction. These are the projects found to be overdue or due now. Still, this includes far fewer overdue gaps than there are in the network overall (15 percent compared with 39 percent) and around the same proportion in the group of roads that might otherwise have been constructed in the 1980s (13 percent compared with 14 percent). Moreover, it may have been the case that the locally-preferred projects had even higher rates of return than those withdrawals.

Allowing substitute choices from a wider range of projects has led to decisions to write off economically unjustifiable segments of the Interstate system. Moreover, cities may well have higher priorities for, say, projects dealing with general urban road improvements, wastewater treatment, or economic development, than for transit or other federally aided highway systems as substitutes for such segments. In view of the high proportion of overdue uncompleted Interstate segments, a city (or a state) might prefer to accelerate completion of its Interstate network by simultaneously cancelling unwanted parts and speeding up construction of extra overdue portions. The 57 percent of remaining gaps with strong traffic justification (those either overdue or due now), for example, could be completed with three to four years' authorizations at the current annual rate for Interstate construction of around $4 billion.

Conclusion

Thus both using performance rather than design specifications and widening the categories of activities eligible for aid result in wider searches for efficient infrastructure projects. In these examples, consideration of a wide range of options for achieving program goals was encouraged by the infrastructure management system. The switch to innovative and alternative technologies for wastewater treatment occurred as states gradually assumed responsibility for managing the program and setting project priorities among different communities claims. Comparisons of different ways to improve mobility were encouraged by relaxing federal rules in favor of guidelines that recognize differences among communities and that encourage a wider scope in local choices for improvements. Appropriate incentives have encouraged communities to cancel construction plans for unneeded highway segments, in favor of other projects.

CHAPTER III

EVALUATING OPTIONS: MEASURING VALUE

Once a public infrastructure management system identifies an array of relevant program and project options, it must measure their relative value. An evaluation system must assess the values of competing but dissimilar options, and must do so in comparable terms. Options must then be ranked according to merit so that those making the greatest contribution to program goals are more likely to be selected. Together, the evaluation and ranking processes must provide consistent information about the consequences of choices involving different types of actions, different effects over time, different risks and uncertainties, and in competition with other programs.

But many federal programs now fail to consider the costs and benefits of their program options over the lives of the facilities in question, and others fail to do so using comparable measures of costs and benefits. This chapter deals with three of the common difficulties found in the current system of evaluating and ranking infrastructure options:

- The failure to use comparable measures of value for projects with different types of effects or for projects that occur over different time spans,
- The failure to compare projects with different lives, and
- The use of "hurdle values" for determining which projects are to be approved.

COMPARABLE MEASURES OF VALUE

To be rational, an evaluation system needs comparable measures of value to bridge differences in projects' engineering and technical aspects, as well as variations in the effects and the purposes they are to serve. Navigation projects intended to allow passage of larger vessels, for example, can entail either raising bridge decks or dredging deeper harbor channels and basins. A proposed navigation project should withstand competition from projects to improve other harbors or channels. Moreover, the evaluation of these projects must incorporate indirect effects that convey real costs--raising a bridge deck may appear cheaper than dredging a channel until the costs of traffic delay caused by the deck construction are considered. Finally, to gain a budget position, all navigation projects should be comparable to projects with as diverse purposes as, say, dam construction.

Uncertainties and risks further complicate evaluations. Degrees of difficulty in arriving at comparable values vary. Planners may be more confident of, say, estimates of construction and operating costs than of responses of users to improvements in service or changes in price. Moreover, underlying assumptions may be uncertain. In other cases, evidence of how people value certain effects must be assembled from behavioral studies--what travelers spend to save time or avoid accidents, for instance, or what houseowners pay to avoid aircraft noise near airports.

Assessing Risks

Analyzing the risks and uncertainties surrounding a project's design can do much more than answer "what if..." questions. If undertaken systematically, a risk analysis can uncover those features of a project's design and those aspects of its implementation requiring management attention.

Few programs recognize that risks or uncertainties affect the viability of capital investments. Feasibility studies for high-speed intercity rail systems in Florida, California, and New Mexico, for example, confidently predicted large potential passenger markets. The Office of Technology Assessment's (OTA) review of high-speed rail potential in the United States, on the other hand, shows that population density in the proposed U.S. corridors is, at best, around one-half that in European high-speed corridors, and less than one-third those in Japan.[1] Such findings call the initial confidence into question. The OTA review concludes that "... any U.S. corridor with totally new high-speed rail service would have difficulty generating sufficient revenues to pay entirely for operating and capital costs." As with feasibility studies, few Environmental Impact Statements or Alternatives Analyses pay sufficient attention to uncertainties to include an assessment under a range of prospects. Furthermore, uncertainties surround not only projected use of new facilities but also other projections about

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1. See Office of Technology Assessment, *U.S. Passenger Rail Technologies*, December 1983.

performance. The following example, using CBO's 1983 study of the National Airspace System plan, shows that realistic projections of cost savings are critical to the project's success. [2]

Managing Risks: Modernizing Air Traffic Control. In 1982, the Congress authorized the Federal Aviation Administration's eight-year plan to modernize the air traffic control system. The FAA's plan has two key elements. First, through automation, the plan is to increase the system's capacity, reduce risks of aircraft collisions and other hazards, and shorten flight times for airliners. Second, by consolidating facilities, the FAA should be able to provide these improved services at lower cost; this is to be done by reducing staff and saving on maintenance. In formulating its plan, the FAA made three key assumptions: that consolidations of facilities would occur on schedule despite past opposition to closing towers from labor and aviation groups and the Congress; that air traffic would continue to increase at annual rates of 4 percent for airlines and 3 percent for general aviation; and that tax collections paid to the Airport and Airway Trust Fund would be enough to provide the $7.6 billion in federal finance.

To test the value of the plan and the risks in implementing it, CBO analyzed it under different assumptions. The suppositions included lower-than-projected air traffic, that tower closings would be delayed or prohibited, that traffic would level off rather than continue to grow rapidly, and that declining airfares, together with slower traffic growth, would mean that Trust Fund revenues would be insufficient to complete the plan. CBO also considered the possibility that owners of private general aviation planes might find too little financial incentive to warrant their investing in the sophisticated equipment needed to receive signals from the proposed microwave landing system, so that the effective use of this part of the plan could be reduced below the FAA's estimates.

This risk analysis disclosed three important findings. First, modernizing the traffic control system was found to be a sound economic investment, but only if the consolidations of facilities proceeded as forecast. If the efficiency gains from consolidation were to be delayed by as little as five years, the economic worth of the plan would be approximately halved; if only half of the productivity increase were ultimately gained, the plan would be of only minor economic value. Maintaining the pace of consolidation was therefore critical to the plan's success. Second, the FAA has a poor forecasting record, with consistently wide differences between actual traffic and the projected volume. While CBO found poor forecasting to have little effect on the economic value of the plan--which derives from gains in productivity rather than from expanding traffic needs--lower demand and declining airfares, if continued, might mean that at current tax rates the Trust Fund would be insufficient to finance the modernization. Though a decision to implement the plan rests on its economic value, managers are thus alerted to a possible need to raise taxes or seek federal fund appropriations. An alternative to either of these courses would be to trim the plan. A candidate for trimming would be the plan's least worthwhile component, the microwave landing systems. Indeed, CBO's third major finding was that this sub-project was, at best, of marginal value, thereby suggesting the option of making selective conversions to the microwave system, if the costs to aircraft of carrying both conventional and modernized avionics could be covered.

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[2] See Congressional Budget Office, *Improving the Air Traffic Congrol System: An Assessment of the National Airspace System Plan* (August 1983).

In other words, the kind of risk analysis that CBO's study of the airspace plan represents not only looks at what can happen if circumstances are less favorable than planners hope, it can also reveal ways to improve a plan's chances of success.

Dealing with Intangibles and Uncertainties

Uneven information about costs and benefits has prompted improvements in some measuring systems. During the 1970s, for example, several techniques were proposed for measuring the health benefits of air pollution abatement to assist comparisons of complex programs in terms of costs for control devices and production output forgone (see Chapter II). For some project features, however, particularly those involving environmental or social values, no evaluation method has been commonly agreed on. Nevertheless, in reaching a decision on which course of action to adopt, program managers are in fact evaluating those intangibles. By choosing to limit traffic at airports to mitigate noise nuisance, for example, managers are actually assessing the nuisance that would have been generated by additional flights as more costly to the community than is the traffic to be diverted or suppressed. As much comparable information as possible must therefore be assembled to validate those evaluations.

In practice, the best measurement systems for comparing options is a mix of the best techniques in each area in question. Typically, managers are presented with evaluated differences among costed items, measured differences in certain other fields (perhaps smoke or noise emissions), and broad assessments of areas of greater uncertainty. A combination such as this narrows the range of uncertainty on the values of unquantified effects by providing thresholds they must meet in order to sway the decision. Comparative, rather than absolute, value guides the selections. Thus, intangibles affecting all options equally can be disregarded. But to reach a decision on others, a program manager must judge whether differences in unquantified effects are valued at more or less than the measured differences among options.

Uncertainties, too, affect measurement. Estimating life-cycle costs and benefits depends on various forecasts of future events: demand levels, prices, equipment availability, maintenance cycles, deterioration rates, and so on. An evaluation system should indicate the extent of these uncertainties and their effects on project rankings. Projects that propose new technologies or major changes in program emphasis are inherently more risky than continuing current operations. Sensitivity to uncertainty, therefore, is an important intangible affecting evaluation of all options.

Comprehensive Measurement

Though federal studies today are wide ranging in the effects they seek to consider (including unquantified intangibles and environmental factors), these systems fail to apply comprehensive measurement to assist in selecting among quantitatively and qualitatively different options. A common failure is that evaluations of projects financed with federal aid typically look at costs and benefits from a strictly local, and therefore narrow, perspective. In 1983, for example, cities provided only 5 percent of the finance for capital improvements on their transit systems from general revenues, while transit agencies and cities together contributed 70 percent of the operating funds needed. Cities' preferences in evaluating options for transit improvements, not surprisingly, tend to pay more attention to reducing local subsidy needs or to attracting other local benefits (such as job creation or commercial development), and rather less to the efficient use of the capital to be invested. In evaluating options to improve Sacramento's transit system, for example, the economic efficiency of the possible investments was listed as eighth in order of priority.[3] Experience in the wastewater treatment program (discussed in the following example) shows that attention to investment efficiency improves when all of the costs are considered.

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[3] See U.S. Department of Transportation Urban Mass Transportation Administration, *Alternatives Analysis/Environment Impact Statement/Environmental Impact Report on Prospective Interstate Substitution Transportation Improvements in North-East Sacramento*, California, unpublished paper (June 1981).

Disregarding Costs and Benefits: Wastewater Treatment. A common fault in infrastructure management is to make choices on the basis of subsidized prices rather than the national costs of the resources used. A recent CBO study of wastewater construction projects found a clear relationship between higher local cost shares and improved investment efficiency. [4] After accounting for the relatively smaller unit costs of larger plants, the analysis demonstrated that reducing the federal share of grants from 75 percent to 55 percent would lead to more efficient investment decisions by local authorities: on average, capital costs for secondary wastewater treatment plants could be reduced by about 30 percent. For example, in the case of a city of 50,000 constructing a secondary treatment plant under the EPA program with 100 percent reserve capacity, a 10 percent increase in local cost share would lead to a 7 percent decrease in lifetime unit costs, a 14 percent decrease in unit capital costs, and a 25 percent increase in unit operating costs. [5]

The CBO study analyzed the relationships between the varying cost shares paid by local communities and the investment efficiency of the projects they undertook. Looking at 68 plants constructed since 1974, with local cost shares varying from 5 percent to 100 percent, the study indicates that such cost savings do not arise evenly across all projects. Rather, they are likely to accrue from very large savings in some projects arising when local choices account more closely for national or total costs. When costs are properly considered, savings are found in five ways: by substituting simpler treatment technology, by exercising rigorous local cost control through local project management, by limiting construction of excess capacity, by focusing on regional planning or regionalized treatment where feasible, and by speeding construction. Clearly, better project management practices are used when costs are properly accounted.

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4. See Congressional Budget Office, *Efficient Investments in Wastewater Treatment Plants* (June 1985). In that study, local cost shares were computed on discounted lifetime costs for construction and maintenance excluding state and federal contributions.

5. This also supports the finding, later in this chapter, that capital bias in federal-aid programs is not manifested in neglect of maintenance. In wastewater treatment, capital bias stemming from the high federal capital match led to local choices that minimized local maintenance expenditures at the expense of increasing federal capital aid.

ACCOUNTING FOR DIFFERENCES IN TIME

A separate set of issues concerns evaluating options that have different effects over time. The costs and benefits of different projects occur over different time profiles. Thus, to make projects comparable, future costs and benefits must somehow be discounted. There is, then, the choice of an appropriate discount rate itself. A discount rate that is too low promotes projects with distant benefits, while a discount rate that is too high penalizes the same projects.

The Use of Discount Rates

Making the effects of projects comparable requires converting the dollar estimates of future effects into equivalent current values. From today's vantage point, future receipts and payments are worth less than the same amounts due or payable now, not simply because of inflation, but because in current resources they require less than their face value. For example, at a 10 percent interest rate, $2 seven years into the future is worth only $1 today, simply because a dollar invested at a 10 percent interest rate will double in value in seven years. Discounting techniques--which translate future receipts and payments into an amount that, if set aside now at expected long-term interest rates, would cumulate to the future amounts--allow all costs and benefits to be considered in terms of current opportunities.[6] That is, discounted present values reflect current oppor-

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6. Although the choice of the rate itself is contentious. See Kenneth Arrow and Robert Lind, "Uncertainty and the Evaluation of Public Investment Decisions," *American Economic Review, 60,* (June 1970), pp. 364-378. Arrow and Lind argue that the risk of investing in public goods is so broadly spread among taxpayers that the value of unanticipated gains or losses to the individual is zero. Therefore, the social discount rate only need incorporate time preference. A criticism of this approach focuses on the issue of dividing and assigning the profits of a public good, which in its purest sense is indivisible and cannot have its profits assigned; see Kenneth A. Shepsle, "Risk and the Discount Rate of Investment Yielding Public Goods: The Arrow Lind Theorem Reconsidered," in Gordon Tullock and Richard Washer, eds., *Policy Analysis and Deductive Reasoning* (Lexington, Massachusetts: Lexington Books, 1982), pp. 167-178. The high discount rate position argues for the inclusion of a risk factor in the public discount rate so that there is not overinvestment in public goods relative to private goods. See Jack Hirschleifer, "Investment Decision Under Uncertainty: Application of the State Preference Approach, " *Quarterly Journal of Economics, 80* (May 1966), pp. 252-277.

tunities forgone in undertaking to pay future costs and current resources made available by future benefits. In business, these more sophisticated practices already prevail in analyzing investment opportunities. By the early 1970s, firms that were regularly making large investments had generally adopted appraisal methods that compare discounted costs and revenues.[7] In the federal sector, however, use of these is rare.

The discounting techniques used so routinely to assess business investment opportunities are not usually applied in federal programs. The cost-effectiveness index the Urban Mass Transit Administration proposed for comparing new transit projects, for example, used single-year comparisons that distort both the size and direction of a project's cost effect and the relative ranking of competing projects.[8] In the water resources programs, which have relatively comprehensive evaluation systems, evaluation results are distorted by the use of outdated discount rates.

The Failure to Discount: New Transit Starts. The cost-effectiveness tests that UMTA proposed for assessing for new transit projects rely on the snapshot data collected for the Alternatives Analysis or Environmental Impact Statement prepared for each proposal. These effectiveness measures combine capital and operating costs at the mid-life of the proposed project by annualizing capital costs over the life of the facilities to be constructed. This looks at the projects from the point of view of a city which has already constructed them. It disregards the reality that capital costs must all be expended over a relatively short construction period at the start of a project, while returns on the investment are recouped slowly throughout the assets' useful lives, and therefore must be discounted.

Basing the cost-effectiveness index on the discounted total for capital and operating costs and user benefits would give a more realistic measure of the value to each city of undertaking its project. (*Table 2 compares such measures with UMTA's 1984 ratings of new start proposals.*) Besides new

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[7] See Thomas Klammer, "Empirical Evidence of the Adoption of Sophisticated Capital Budgeting Techniques," *The Journal of Business*, vol. 45, no. 3 (July 1972).

[8] Urban Mass Transportation Administration, *A Detailed Description of UMTA's System for Rating Proposed Major Transit Investments*, U.S. Department of Transportation, (May 1984).

TABLE 2. COST-EFFECTIVENESS MEASURE FOR NEW TRANSIT STARTS, 1984

UMTA Cost-Effectiveness Ranking a/			Discounted Cost Ranking b/		
Rank	Project	Index (In dollars) c/	Rank	Project	Discounted Cost (In millions of dollars)
1	St. Louis Bus	d/	1	St. Louis Bus d/	-17
2	Seattle Bus Tunnel	-0.9 per Rider	2	Houston, Northwest Bus	80
3	Los Angeles Rail	+ 1.46 per Rider	3	Houston, Southwest Bus	125
4	Houston, Northwest bus	+ 2.59 per Rider	4	Seattle, Bus Tunnel	132
5	Houston, Southwest Bus	+ 4.09 per Rider	5	St. Louis Rail	147
6	Detroit Rail	Disqualified	6	Detroit Rail	848
7	St. Louis Rail	Disqualified	7	Los Angeles Rail	1,303

SOURCE: Congressional Budget Office and data provided by the Urban Mass Transportation Administration.

a. Based on annualized capital costs and mid-life operating costs, and user time savings.

b. Based on discounted capital and operating costs, and time savings.

c. Cost indexes are measured from a baseline of improved traffic management under the existing transit arrangements. Thus a plus sign indicates the project would increase the cities' overall cost; a minus sign projects an overall cost saving.

d. Not included in UMTA ratings, but alternatives analysis showed this to be a superior option. UMTA's disqualification of the rail project in St. Louis is based on its attracting fewer riders than the bus option.

starts rated by UMTA, Table 2 includes a St. Louis bus option; this is not a new start but an option that emerged in the planning for the St. Louis rail project and that was found to have the potential to attract more riders at about one-sixth the cost. Apart from this option, none of the proposed projects listed would retain its suggested place in the UMTA cost-effectiveness ranking if evaluated according to discounted costs taking proper account of the expected future flows of costs and benefits. The Seattle bus tunnel, rated most cost effective under the UMTA procedure, drops to mid place; the Los Angeles rail project, found by UMTA to warrant second place, actually is the least economical of all.

Perhaps more important, ignoring a project's profile of future costs has apparently converted a cost into a benefit. According to UMTA's calculation, the Seattle project appears to save around 90 cents for each new rider it attracts. This is an illusion, however, caused by the artifical spreading of capital costs over the structure's long life, rather than over its projected four-year construction schedule. The discounted cost analysis shows that Seattle actually faces committing a net additional $132 million to the transit system over the first 20 years of the project's operation. Only in the case of the St. Louis bus project are costs forecast by project planners to be less than benefits.

Using Outdated Discount Rates--Water Resources. Though water resources programs have well documented systems for evaluating projects, they apply the procedures in ways that distort choices. Current procedures do not apply consistent tests of economic worth to projects making current claims for funding. Often, local preferences are allowed to dictate the options considered, and project effects that attract development at the expense of other areas and groups are counted as project benefits. Of greater current concern, however, is the practice of using historical rather than expected borrowing rates in evaluating the priority of approved projects for continued funding. Budget requests for water resources projects are based on evaluations using discount rates ranging between 3 percent and 9 percent.

At a 3 percent discount rate, benefits accruing after 30 years are counted as valuable today as benefits accruing eight to nine years hence when discounted at rates around 10 percent. All projects showing benefits greater than costs are classified as "active" and qualify for financing. The low rates thus attract current budget resources to projects with low and slow payoffs, mostly benefiting future generations. Projects authorized far exceed the resources budgeted for completion, but the evaluation procedure fails to give clear guidance on which projects should be completed first. Annual appropriations for the Corps of Engineers have been averaging about

$1.4 billion, compared with an approved list of $22.7 billion in projects to complete; for the Bureau of Reclamation, appropriations have averaged $503 million a year as against $12.8 billion in projects.

In looking at these programs, the General Accounting Office (GAO) has found not only a low federal confidence in the need to complete construction in many cases, but also a reluctance or even refusal on the part of local authorities to share in financing. 9/ If priorities among projects were clearly sorted out by applications of a common discount rate and if there were an effective way to retire projects, many of the backlog projects would be removed from project lists or modified. GAO reports the Corps' estimate that half the active project list should probably be discontinued.

A look at the Corps' 1986 budget request for construction projects suggests that the list of approved projects could indeed be substantially cut without economic loss. The 1986 request includes 84 construction projects that are less than 80 percent completed and for which the result of an economic evaluation is available. The combined worth of these projects is $15 billion, of which $5 billion has already been spent. For 33 of these projects, no construction work has yet been undertaken. According to the Corps' estimates, all the projects have ratios of discounted benefits to discounted costs of 1-to-1 or more: the lowest ratio is 1.02-to-1 (at an 8.375 percent discount rate) and the highest is 27.3-to-1 (at a 2.625 percent discount rate).

Were the discount rates the same, a higher ratio of benefits to costs would indicate a stronger economic justification for the second project. But because the discounted amounts reflect both the timing of benefits and costs, as well as the discount rate, the Corps' ratios give no information on the relative worth of the two projects. Moreover, because the 2.625 percent rate is so much lower than the other, whether or not the second project would achieve the minimum 1-to-1 ratio at the higher rate is unclear.

For the 84 projects proposed, present values (that is, the difference between discounted costs and discounted benefits) have been recalculated, using a 10 percent discount rate for all projects, but using the Corps' estimates of annual benefits and operating costs and projected completion dates for construction. All projects were assumed to have 30-year lives before major rehabilitation expenditures would be needed and to be 100 percent productive from the first day of operation. Both of these

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9. See General Accounting Office, *Water Project Construction Backlog--A Serious Problem With No Easy Solution*, GAO/RCED-83-49 (January 26, 1983).

assumptions tend to favor projects. Even so, the present values for 34 projects are negative. In other words, if these projects were completed, the remaining construction costs would exceed the benefits generated over a 30-year operating life. With nonfederal shares included, the proposed 1986 expenditure on projects with negative net benefits is about $350 million, and the combined value of the projects is $6 billion. Were these projects cancelled instead, future expenditures of some $4.4 billion could be saved. If this amount were redirected to completing projects with positive present values, these projects would be finished about six years earlier.

Clearly, a more accurate picture of current commitments, as well as a better understanding of priorities, would follow from simplifying the procedures for reviewing priorities for long-lived projects and for terminating projects that, as planning proceeds, are found to be of dubious economic worth. This process would apply not only within the multiple purposes in the general water resources category--irrigation, flood control, power generation, and shipping--but also among other purposes. Before 1970, there was no process by which an approved water resources project could be cancelled if found later in the planning process to be unwarranted. Now a project can be scrapped, but a minimum of eight years passes between when it is first deactivated and finally withdrawn. In the interim, apparent federal commitments to water resources development are inflated, and financing for worthwhile substitute projects is deferred.

THE LIFE CYCLE APPROACH

Finally, there is the issue of whether projects with different duration--such as pothole filling and road resurfacing--are allowed to compete equitably for approval and funding. Taking a life-cycle approach in comparing options deals consistently with differences in the timing and durations of events and their effects. To compete on equal terms, proposed projects with high initial costs but long-term effects, others requiring small repeated corrections with shorter impacts, and a policy of maintaining current operations must all be compared over a span long enough to reflect all the costs and benefits. When capital investment is one of the options, this can mean projecting costs and other consequences over 20 or more years, reflecting the useful lives of assets to be provided. Under its Technology Sharing program, for example, the UMTA distributes a report to local users on a simplified method for making life-cycle cost comparisons between bus rehabilitation and purchasing new buses.[10/] Bus rehabilitation involves

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[10] Puget Sound Council of Governments, *The Role of Rehabilitation in Transit Fleet Replacement*, U.S. Department of Transportation (March 1983).

lower initial costs but greater maintenance and a shorter useful life; bus purchases increase investment costs, but they lower maintenance and extend useful time in service.

Not considering costs and benefits over the life of projects discriminates against options requiring investment, tending instead to favor options with low current costs. The crudest patching methods for potholes in roads, for instance, will always appear cheaper than reconstructing badly deteriorated pavement, unless the costs of repeating the patches each two to six months is compared over a seven-year or longer initial life for the new pavement. Technological changes in infrastructure systems and strategic modifications for achieving goals are more likely to be carried out when the management system takes a long-term view.

Measuring Life-Cycle Costs

Though broadly based, examples of evaluation systems that lack the life-cycle approach, can be found in Environmental Impact Statements, and in Alternatives Analyses for new transit proposals. In most cases, these planning studies give snapshot comparisons of different courses of action, usually for a single year somewhere near the mid-life of a favored solution. Though often broad enough in coverage to include information and all of the various proposals' important advantages and drawbacks, the limited depth of that coverage--a single mid-life year--leads to two biases that have distorted infrastructure choices

First, looking only at projections for a single year distorts the apparent relative importance of capital and operating effects. A proposal to reduce transit deficits by investing in new transit network, for example, may seem attractive. But for the investment to be worthwhile, the cumulative cost savings over the service life of the assets being considered must be enough to offset the investment. The final Environmental Impact Statement for the proposed rapid rail project in Los Angeles, for example, showed that construction of an 18-mile rail subway would reduce the city's annual transit system deficit from $279 million under improved operation of the bus system to $113 million, while constructing a "minimum operable" rail line of 8.8 miles would reduce the city's annual transit deficit to $169 million.[11] When compared over a 30-year operating life for the system, however, the apparent preference for rail development reverses. Discounting investment and net operating costs over the life of the assets shows that the cumulative costs for the city's "preferred" option would have been $3.6 billion, and that the minimum segment would have cost $3.2 billion, compared with $2.7 billion for improved traffic management under the current bus-based system. Reducing the city's annual deficit through rail development would thus require a commitment to provide between $500 million and $900 million in additional resources to the transit system over and above those needed under improved management for the current network.

Second, looking at distant future effects without a near-term perspective distracts decisionmakers from questioning the implementation strategies for the different options. It also raises difficulties for assessing the credibility of assumptions and forecasts used to project effects. In Pittsburgh and Miami, for example, new rail transit systems have recently opened with large but unexpected operating deficits, and thus no assured source of financing for operations and maintenance. In Miami, daily ridership was initially only one-tenth that predicted in the federally accepted "feasibility" study. In Pittsburgh, initial use was only 20 percent of that applied in comparing project options. After opening new lines such as these, local officials find themselves having to provide large new public subsidies or to close the new systems down.

Managing Lifetime Impacts--The Highway 4R Program

The life-cycle approach is also important--but rarely used--in managing programs that provide both capital and operating subsidies. Prime examples are to be found in transit and highways. Currently, divisions of federal aid between these two categories are not based on assessments of the appropriate balance of capital and operating projects that will achieve the program goals. The following assessment of highway spending for resurfacing, restoration, rehabilitation and reconstruction (termed "4R") shows how this has affected the amount and quality of roadworks.

Observers often cite a capital bias in federal infrastructure programs, arguing that the federal policies for assisting investment have caused nonfederal agencies to neglect operations and maintenance. Broadening the aid to encompass operations and maintenance activities, they hold, can correct this capital bias and make the programs more efficient.

To show capital bias, however, capital spending would have to be more than needed, and that for maintenance and operations less. To date,

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11. U.S. Department of Transportation, *Final Environmental Impact Statement, Los Angeles Rail Rapid Transit Project,* Southern California Rapid Transit District (December 1983). Dollar amounts are in 1983 prices.

thorough reviews of the adequacy of highway investments have been made only for the Interstate network.[12] These reviews tend to show mixed results--in general, overinvestments on rural segments and underconstruction in urban areas. But the reviews do not lead to firm, broadly based conclusions as to whether or not there has been overinvestment in the federal aid system. The broadening of the highway program to include 4R does, however, offer some insight. Monitoring pavement condition shows that, overall, maintenance spending has been sufficient to keep the highway network in generally good shape. The allocation of maintenance among subnetworks, however, does not ensure that the highway transportation system is as efficient as it could be for the amount spent. A detailed review of these findings follows.

Rather than the neglected condition that would tend to confirm less-than-adequate maintenance on the federally aided highways, pavement ratings are consistent with higher-than-routine maintenance budgets. In other words, limiting highway assistance to capital programs until the mid-1970s caused neither neglected maintenance nor increased deterioration. What emerges from the comparison is that states have spent enough to keep ahead of age-related highway deterioration. Nationally, the federal aid highway system is in much better condition, as reflected by the Federal Highway Administration's (FHWA) pavement-rating system, than its age would indicate. Estimated roughly on the basis of road mileage put in service each year since the mid-1950s and standard deterioration rates under routine maintenance programs, about 40 percent of highways (those built most recently) would be in "good" or "very good" condition, but more than half of the highway mileage would be in "poor" or "very poor" condition. In contrast, the FHWA's 1985 Status Report for the highway system reports nearly 50 percent of the network as good or very good, with only 15 percent rated poor or very poor.[13] Further, the proportions of good roads are generally higher and poor roads generally lower for Interstate segments than for other categories of the federal-aid network. (*These comparisons are shown in Table 3.*)

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12. See, for example, Ann Fetter Friedlaender, *The Interstate Highway System, A Study in Public Investment*, Contributions to Economic Analysis No. 38 (Amsterdam: North Holland Publishing Co., 1965).

13. Report of the Secretary of Transportation to the United States Congress, *The Status of the Nation's Highways: Conditions and Performance*, June 1985. The terms "very poor," "poor," "fair," and "good" for road conditions conform to those used by federal and state highway authorities, and to the sufficiency rating classes illustrated in Table 3.

TABLE 3. CONDITION OF THE FEDERAL AID HIGHWAY NETWORK COMPARED WITH ITS AGE

Condition		Percentage of Federal-Aid Network		
			Reported Condition 1983	
Present Serviceability Rating a/	Rating	Age-Based Estimate 1983 b/	Inter-states	All Federal Aid
Four or Better	Very Good	30	31	17
Three to Four	Good	9	41	30
Two to Three	Fair	10	14	38
Below Two	Poor and Very Poor	51	14	15
Network Total	--	100	100	100

SOURCE: Congressional Budget Office and data provided by the Department of Transportation.

a. A grading system routinely used by highway agencies to assess pavement condition.

b. Estimate of age-based condition is based on data on road mileage put in service each year since the 1950s, and standard road deterioration rates under routine maintenance.

But it is not self-evident that keeping all roads in excellent condition is a worthwhile investment. This is broadly confirmed by the Department of Transportation's recent study which estimated the effects of different levels of highway investment. 14/ The study found that broad positive effects would result from maintaining highways at 1978 standards. At the same time, though, it found that the extra investment needed to repair all deficiencies, averaging around $3.6 billion a year, would provide no appreciable return. Whether in fact highway maintenance has been too much or too

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14. See U.S. Department of Transportation, Transportation Systems Center, *Highways and the Economy, FHWA/PL/33/014, DOT-TSC-FHWA-83-1* (November 1983). The amount quoted is expressed in 1980 prices.

little depends on the costs that road conditions impose on users. The extent of traffic use and the condition of sub-networks of the federally aided system indicate a poor allocation of highway budgets for major maintenance that detracts from goals for transport efficiency.

Improvement in a road from poor to good condition means less wear and tear on vehicles and tires, better fuel economy, lower risk of accidents, and shorter journey times. These can add up to a saving in vehicle costs of up to 25 percent. Improvement from fair to good, however, costs roughly the same, but it saves only 8 percent to 10 percent in journey costs. Thus, at current cost levels and allowing for an average volume and mix of traffic, investments to improve roads in poor or very poor condition would have rates of return over the life of the improvements of around 20 percent, while improvements to roads in fair condition would return only around 8 percent to 10 percent, barely equal to the cost of raising funds for the work. 15/ A highway program manager maximizing returns (assuming traffic to be equally distributed over road types) would therefore prefer to use additional maintenance resources to upgrade the 15 percent of federal-aid highways in poor or worse condition before correcting the relatively minor defects in fair or good roads. Accordingly, budgetary requests for road rehabilitation and maintenance could be allocated among highway segments to minimize the costs of the road transport system (maintenance plus vehicle operations) for prospective traffic. This process--comparing road improvement costs with resulting reductions in road service costs over the duration of the improvements--would tend to direct funds to those road sections in worst condition and those with heaviest traffic. 16/

Without such a process of comparison, projects to repair fairly minor deficiencies on lightly trafficked corridors drain off resources. As a result, pavement conditions in poor sections and those where deficiencies are highly visible--in cities and on other high-traffic corridors--continue to deteriorate even with an augmented rehabilitation program. The 1985 Status Report confirms that such draining-off is happening. Since 1975, pavement conditions on the most densely traveled routes--urban segments of the Interstate network--have declined, with the proportion in poor or very poor

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15. Based on Federal Highway Administration, *Vehicle Operating Costs, Fuel Consumption, and Pavement Type and Condition Factors*, Final Report (June 1982), and *Highway Statistics 1983*.

16. Improving roads in the worst conditions would give relatively high returns because they provide large reductions in transport costs per journey; improving busy roads provides large total benefits through smaller cost savings for a larger traffic volume.

condition doubling (see Table 4), and that in each of the good and very good categories declining. In contrast, on rural collector routes, which have the least traffic, road conditions improved overall, with drops in the share of the network in poor or fair condition, and increases in the extent of good and very good roads. On other low-density networks--non-Interstate rural arteries and urban collector routes--the major change has been a lessening of the extent of the network in fair condition in favor of more pavement in good or very good condition. For routes of medium-density, the record is mixed. For both Interstate rural segments and non-Interstate urban arteries, the proportion of the network in the poorest condition has grown since 1975. But whereas the principal change in urban areas has been in improvements of good roads to very good condition, on the main Interstate network, very good segments have deteriorated to fair and only good condition.

Major highway maintenance to date must then be judged as both too much and too little--too much on the relatively lightly traveled rural networks in fair or better condition, and too little on Interstate segments in fair shape or worse. Reassigning priorities for highway programs so that projects are undertaken in order of the value of the benefits they offer over their useful lives would overcome such misallocation in the current program.

Using life-cycle costing for road transport in determining and allocating highway budgets would thus allow simultaneous consideration of which construction projects to undertake and at what standard to maintain the existing network. Candidate projects could be compared according to their effects on transport efficiency and the extent to which they could reduce transport system costs. Spending could be directed to those parts of the network and to those missing links that would make the greatest contribution to national goals. At the same time, though, it would be diverted from those parts that offer little improvement or none at all.

THE USE OF "HURDLES" *VERSUS* RANKINGS

Though many local governments rank options to compare the spending bids of different agencies, no federal program now formally queues proposals in the order in which they might promote national goals. (*Examples of local practices are described in Box 5.*) In those federal programs that make some use of evaluations, federal managers apply "hurdle," or threshold, values for measures of merit and admit all projects that can pass the test. Water resources project lists, for example, include all investment projects with positive ratios between discounted benefits and costs (treated in detail

TABLE 4. HIGHWAY PAVEMENT CONDITION BY SYSTEM IN 1975, 1978, AND 1983

Functional System and Year	Total Miles	Traffic Density	Pavement Rating								
			Poor and Very Poor		Fair		Good		Very Good		Average Rating
			Miles	Per-cent	Miles	Per-cent	Miles	Per-cent	Miles	Per-cent	
Interstate--Rural											
1975	29,938	3.9	3,113	10.4	2,342	7.8	9,596	32.1	14,887	49.7	3.4
1978	31,161	4.4	3,116	10.0	4,487	14.4	10,219	32.8	13,339	42.8	3.3
1983	32,788	4.4	4,295	13.1	4,263	13.0	13,803	42.1	10,427	31.8	3.2
Interstate--Urban											
1975	8,671	14.8	746	8.6	1,186	13.7	3,222	37.2	3,517	40.6	3.4
1978	9,048	17.4	986	10.9	1,475	16.3	3,167	35.0	3,420	37.8	3.3
1983	10,240	18.7	1,792	17.5	1,679	16.4	3,687	36.0	3,082	30.1	3.0
Other Arterials--Rural											
1975	234,705	1.1	26,052	11.1	80,286	34.2	75,613	32.2	52,754	22.5	3.0
1978	232,096	1.2	23,906	10.3	88,893	38.3	63,130	27.2	56,167	24.2	3.0
1983	228,770	1.2	24,250	10.6	75,524	33.0	83,013	36.3	45,983	20.1	3.0
Other Arterials--Urban											
1975	115,511	3.7	10,396	9.0	44,341	38.4	40,494	35.1	20,280	17.6	3.0
1978	117,559	3.7	11,521	9.8	48,317	41.1	32,446	27.6	25,275	21.5	3.0
1983	123,462	4.1	12,470	10.1	47,533	38.5	36,791	29.8	26,668	21.6	3.0

(Continued)

TABLE 4. (Continued)

Functional System and Year	Total Miles	Traffic Density	Pavement Rating								
			Poor and Very Poor		Fair		Good		Very Good		
			Miles	Per-cent	Miles	Per-cent	Miles	Per-cent	Miles	Per-cent	Average Rating
Collectors--Rural											
1975	737,748	0.2	132,057	17.9	346,646	47.0	178,048	24.1	80,997	11.0	2.6
1978	734,678	0.2	130,038	17.7	349,707	47.6	174,118	23.7	80,815	11.0	2.6
1983	734,338	0.2	126,306	17.2	291,532	39.7	204,881	27.9	111,619	15.2	2.7
Collectors--Urban											
1975	65,209	1.0	8,477	13.0	31,365	48.1	18,423	28.3	6,944	10.6	2.7
1978	67,292	1.1	12,381	18.4	32,435	48.2	14,536	21.6	7,940	11.8	2.6
1983	72,513	0.9	11,530	15.9	30,600	42.2	18,708	25.8	11,675	16.1	2.8
All Systems											
1975	1,191,782	1.1	180,841	15.2	506,166	42.5	325,396	27.3	179,379	15.1	2.8
1978	1,191,834	1.1	181,948	15.3	525,314	44.1	297,616	25.0	186,956	15.7	2.8
1983	1,202,111	1.1	180,643	15.0	451,131	37.5	360,883	30.0	209,454	17.4	2.8
Estimated Age-Based Condition											
1983	1,199,559	1.1	611,775	51.0	119,956	10.0	107,960	9.0	359,868	30.0	2.3

SOURCE: Department of Transportation and Congressional Budget Office estimates.

a. In millions of vehicle miles of travel per mile per year.

below). The process for rating new transit starts is based on arbitrarily chosen levels of "cost effectiveness." These reflect not how much a new transit project will improve the system's productivity, but a maximum additional cost per passenger that can be imposed by the project under review. Further, federal managers do not consistently channel financing to the most cost-effective projects discovered through the evaluation procedures they oversee.

Project comparisons under sound management practice must usually span differences in engineering and technical disciplines, as well as differences in purposes, goals, and outcomes. Formal ranking systems help these comparisons by summarizing the evaluations of project options and exposing where projects proposed in different programs have similar prospects in type or amount and where effects differ. Comparing rankings in different areas of effect--measured benefits and costs, intangibles of different sorts, and risks--provides qualitative information important to choices. Aspects of equity and fairness can be reflected in ranking criteria and taken into

BOX 5
RANKING CHOICES TO SET CITY PRIORITIES

In the ranking procedures many local governments follow, sponsors submit ratings of how each project promises to satisfy a number of criteria. These usually cover a wide list of economic and social effects, but ratings are commonly subjective. Dayton, Ohio, for example, rates projects on 18 criteria, but only according to broad categories of major, minor, or no effect. Ranking criteria also often overlap. Minneapolis rates projects on 14 criteria, including closely related categories of environmental quality, quality of life, health, safety, general welfare, and public benefit. Weights assigned to each category are combined to produce an overall summary score for each project. In Nashville, Tennessee, the weights are adjusted by specific values reflecting priority for projects in low-income areas. Hence, though more careful measurements of projects' outcomes would correct much of the subjectivity in these systems (overlapping ratings, if anything, help in this by providing extra information aiding interpretation of very general effects), the ranking procedures nevertheless assist cities in making trade-offs among goals, and in making those trade-offs apparent to both responsible agencies and citizens for whom services are intended.

SOURCE: For further information, see Harry P. Hatry, *Maintaining the Existing Infrastructure Current "State-of-the-Art-and-Practice" of Local Government Planning*, (Washington, D.C.: Urban Consortium, 1981).

account in making budgetary choices. Program ranking, based on the relative worth of marginal projects in different system programs, would advise multi-system managers about where to apply additional resources or where to make cutbacks.

Ranking options after evaluation avoids the rigidities inherent in procedures that simply admit all projects passing over some pre-set hurdle. First, such hurdles cannot adequately reflect qualitative differences. Hurdles are most commonly set in terms of benefit/cost measures, so that those projects for which measurements are more easily or more assuredly made will always appear more attractive. Second, any hurdle value would have to reflect decision criteria not of the day budgetary choices are made but over the period during which budgetary choices will be implemented, which in turn will be somewhat influenced by those choices.

Third, hurdle values are easy to simulate. Analysts may be pressured to vary forecasts or other estimates to produce results that pass known tests of acceptability. Thus, more than one-third of water resources construction projects proposed by the Army Corps of Engineers pass the Corps' "acceptability test" with minimum of benefit/cost ratios of less than two-to-one. Further, seven of the water resources projects proposed to begin in 1986 meet the minimum standard only by using a discount rate only little more than one-third of the 8.375 percent rate applied in evaluating other proposed new starts. Similarly, forecasts of demand for aviation and rail projects are frequently overoptimistic, often exaggerating achievable gains many times over. 17/

CONCLUSION

Effective management of public works infrastructure requires that dissimilar and competing program and project options be evaluated in consistent terms that allow comparison. (*Box 6 describes the evaluation procedures under the federal Highway Bridge Replacement and Rehabilitation Program.*) Once evaluated, the options must be ranked so that those promising the greater contributions to the program's goals are the more likely to be selected. Together, the evaluation and ranking processes must

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17. These problems are not unique to U.S. studies. The World Bank, for example, finding overoptimism and over-ambitiousness common in railway planning, has specified "realistic traffic forecasts" as the first of six criteria for railway projects proposed for financing. See *The Railways Problem*, Transportation, Water and Telecommunications Department (Washington, D.C.: World Bank, January 28, 1982).

BOX 6
EVALUATING OPTIONS-- THE BRIDGE REPLACEMENT PROGRAM

The Department of Transportation's Highway Bridge Replacement and Rehabilitaiton Program uses a comprehensive and consistent system to guide project selection. Though not a benefit/cost ranking, the system's Sufficiency Rating scale combines measures of physical condition of bridge structure, limits imposed on traffic, volume of traffic affected, extent of detours needed, and such special features as importance for defense.

The selections are based on biennial inspections of all bridges to identify those with inadequate load-bearing strength and those that no longer meet other federal design standards. A wide range of remedial actions is tested. The program has found that, with proper maximum-load posting and enforcement, structurally deficient bridges can continue to handle most traffic. Measures such as pavement and obstruction marking and traffic signals are also used to minimize the hazards in design faults. Such operational changes are estimated to provide acceptable long-term solutions for about one out of five below-standard bridges.

Eligibility for capital improvements is determined by a sufficiency rating combining engineering and impact assessments. Bridges are rated on a scale of zero (worst) to 100 (best). A heavily trafficked bridge with moderate deficiencies may be rated lower and receive a higher priority for capital improvements than a bridge with more severe faults but only occasional and light traffic. Bridges rating 80 percent "sufficient" or better are not eligible for capital improvements. Below this, two cutoffs are used to encourage comparisons of different capital solutions. If ranked in the lowest category, a bridge will be eligible for replacement, but only if this course is more cost effective than rehabilitation. In the middle category, only rehabilitation projects attract federal aid.

The ratings are used to prepare selection lists for bridges eligible for rehabilitation and replacement, from which states (taking account of such local issues as school bus routes) choose projects for implementation. States' apportionment factors are revised regularly to reflect changes in the list of aid-eligible projects and construction costs. Thus the selection process is comprehensive, consistent, and fair. A wide range of solutions and their effects are explored. National standards are applied to all bridge proposals to determine eligibility, modified in the final stage by local preferences. And each state's access to aid is proportionate to program aims.

provide consistent information about the consequences of choices involving actions with different effects over time, and with different uncertainties and risks. The process must permit comparisons of operating and capital solutions, and it must allow actions that might be taken under one program to be weighed against those under others.

Though a long range view is essential, many federal programs do not consider the effects of choices over the expected lives of facilities to be provided, and those few that do often fail to provide comparable measures of costs and benefits. These limitations result from several practices. Costs and benefits not accruing to public agencies, or sometimes accruing to agencies not party to the current project choice, are often disregarded, even when the costs and benefits are part of complementary investments or services critical to the project's success. Moreover, discount rates sometimes reflect historical, rather than expected, borrowing costs; thus, future benefits appear much more valuable than in fact they are. As a result, well justified new projects are delayed, while poorer choices with lower benefits that were selected in earlier periods are implemented.

CHAPTER IV

EVALUATING OPTIONS:
CHOOSING A BASELINE

A separate class of problems concerning evaluating infrastructure program options concerns the choice of a basis for comparison. A project such as a dam, for example, may have a "rate of return" of 15 percent, or may lead to "discounted net benefits" of $100 million, which represent society's gain when one compares an imagined future world that contains the dam in question to an imagined world without it. But what would exist in the absence of such a dam? How would the resulting pattern of economic activity change? This chapter examines this issue.

THE "NOTHING HAPPENS" BASELINE

The prevailing assumption underlying most federally supported feasibility studies and much federal infrastructure policy is that, without federal intervention, no infrastructure development would occur. In other words, the main basis for comparison is a "nothing happens" baseline. Evaluation of a public transit project, for example, takes as its comparative basis a traffic management option. This assumes that the city in question will not continue to invest in improved transportation systems (which, realistically, include roads) unless the federal-level project under study is undertaken. A more appropriate base case would be the best plan for improving urban mobility that the city could finance without the federal project.

Using a "nothing happens" basis for comparison fails to adjust demand for the project's services to the no-investment case. Plans for a water resources project, for example, typically enumerate benefits as though, if the project were not to be carried out, people would continue to settle in flood plains or to farm deserts, and shippers would contend with shallow ports. A more rational prediction of the without-project case would attempt to show how settlers, farmers, and shippers would react to a different set of cost or pricing incentives.

The choice serving as a comparative baseline should be a careful projection of how infrastructure systems would develop under current policy with the guidance of sound management. Thus savings in operating costs from new techniques, say, should be measured not against a baseline of current productivity rates, but against a projection of productivity changes both apparent and achievable through ordinary application of good management practices. Forecasts of "with project" impacts must similarly be carefully developed as best estimates of likely, rather than optimistic, outcomes. The following analysis of the transit program shows how the management of city transport systems might function if analysis of the likely evolution of transit had guided policy.

Choosing a Basis for Comparison- -The Example of Transit Modernization

Both the cost structure and the regulatory pattern of current policy on transit aid follow from the perception of nearly 25 years ago that federal intervention was needed to avert widespread abandonment of transit services. Testimony presented at hearings on the 1964 Act emphasized the consequences of such abandonments, including effects on urban development and such traffic results as congestion as well as additional highway construction and vehicle purchases. Estimates were presented that, if commuter rail services were abandoned in Boston, Chicago, Cleveland, Philadelphia, and New York, the replacement highways needed would cost $31 billion. Abandoning the mass transit system in Chicago was estimated to add to the city's transport system 600,000 automobiles, 160 new expressway lanes, and extensive parking areas. Annual costs of $5 billion a year for lost time, fuel, and other costs of traffic congestion were cited. 1/ The first priority of the Urban Mass Transit Administration in administering the transit capital grants program was "preservation of existing transit systems which would otherwise be abandoned" with efforts to improve and extend transit services receiving only second- or third-level attention. 2/

Rather than seek the best "without assistance" plan for improving mass transit, federal transit aid has derived from the assumption that subsidies are at all times and under all circumstances needed to retain the transit services critical to reducing urban congestion and conserving fuel. Without subsidies, according to this assumption, high fares would divert riders to automobiles, and public services needed for special groups- -including both those people without the use of private autos and those, such as the disabled, with special transit needs- -could not be provided.

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1. U.S. House of Representatives Banking and Currency Committee, House Report-No. 204 (to accompany H.R. 3881), *The Urban Mass Transportation Act of 1964* (April 9, 1963).

2. George W. Hilton, Federal Transit Subsidies, The Urban Mass Transportation Assistance Program, American Enterprise Institute Evaluation Studies, No. 17 (June 1974).

The federal transit program has pursued modernization and preservation of existing systems through subsidies at the expense of other options for improving urban mobility. A look at UMTA's program, however, shows that the subsidies themselves may have caused a gap to grow between the networks of transit services available and the patterns of demand for urban travel. A result of that gap has been the marked diminution of the importance of transit services, except within finite downtown areas. Growth of major metropolitan and other urban areas during the 1950s fast outpaced the development of urban transport systems. With declining transit ridership during the decade came a general deterioration of bus services. Deliveries of new buses during the second half of the 1950s were fewer than one-third of the total ten years earlier. Failures and near failures of transit companies generated concern that even large cities could be left with no public transit. Modernization and coordinated planning were the solutions adopted, with emphasis concentrated on making up the backlog of deferred investments and little attention paid to the reconfigurations evolving in urban areas themselves.

The stress on preserving existing networks obscured the importance of efficiency-oriented changes that might have made mass transit competitive in modern metropolitan areas. Bus services are most efficient when waiting times are short, routes offer (as nearly as possible) direct door-to-door service, and necessary connections are easy. Today, with focuses for trip making in modern cities split among many suburban and downtown centers--for living, shopping, work, and entertainment-- transit services that would maintain short service intervals over wide route coverage would use small vehicles: small buses, vans, jitneys, and even taxis. Over very wide ranges of costs, the higher frequencies that bus companies could profitably offer with vehicles smaller than those most transit fleets use would reduce the costs of waiting time to riders by more than the increase in costs for vehicle operations for the more numerous services. As a result, the overall cost of commuter operations would decline. [3]

Under prevailing U.S. transit costs, the cost reduction when a typical system switches from the largest type of bus to small buses or vans might be in the range of 20 percent to 25 percent. (*Figure 3 displays UMTA's data on the costs of providing transit service with four vehicles.*) In each case, the cost reflects vehicle and commuters' time costs for 100 riders, and trip frequencies are adjusted to maintain average loadings of 60 percent of typical capacity (including standees). Thus the large bus, with capacity for

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3. See A.A. Walters, "Externalities in Urban Buses," *Journal of Urban Economics*, Volume 11, January 1982.

62 riders, is assumed to carry an average of 37 commuters, and a bus company would make 2.7 trips an hour for each 100 riders. On the other hand, vans have 12 seats and an average load of seven riders, and operators would offer 14.3 services an hour per 100 commuters. Passengers arriving at bus stops randomly would then wait an average of 11 minutes for a large bus (half the interval between bus arrivals) or two minutes for a van. Time at stops would also be lower for smaller vehicles simply because fewer passengers would board or get off. Transit time would be similar for all cases, because the disruptions caused by large buses' pulling into and away from curbs roughly offset the effects on traffic of the numerical increase of

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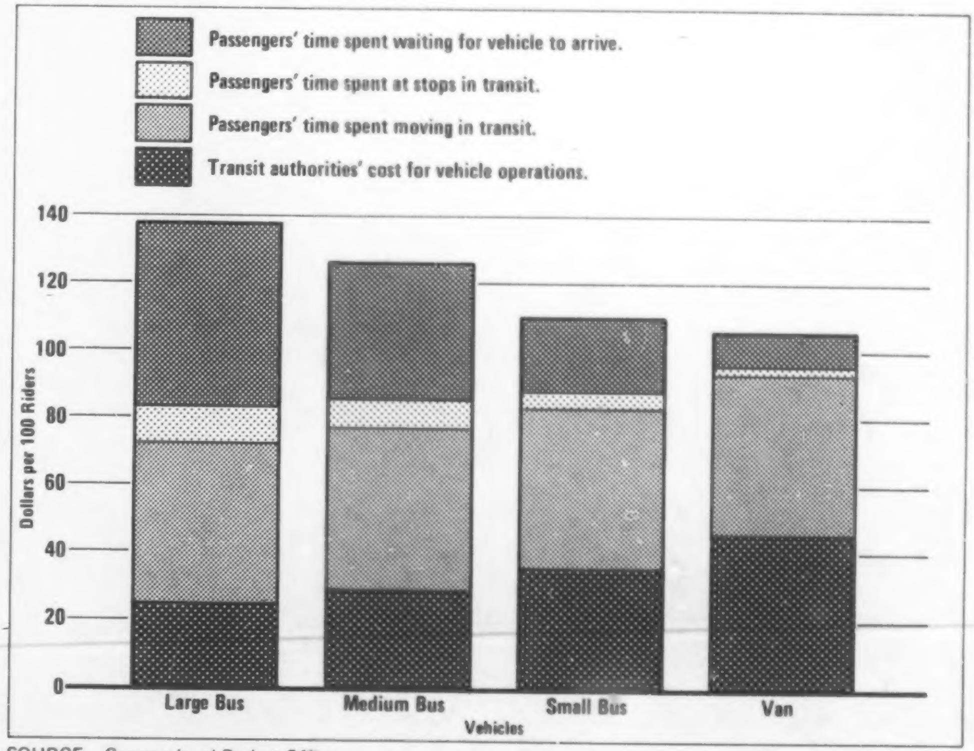
Figure 3.

Comparison of 1984 Public Transit Costs for Four Vehicle Types (Costs in 1984 dollars)



SOURCE: Congressional Budget Office.

NOTES: Based on data from Urban Mass Transportation Administration, *National Urban Mass Transportation Statistics 1983, Section 15 Annual Report*, (December 1984). Costs are in 1984 prices. "Large Bus" represents UMTA's Class A bus with more than 35 seats; "Medium Bus" represents Class B bus, with 25 to 35 seats; "Small Bus" represents Class C bus, with fewer than 25 seats. Vans have 12 seats. Time is valued at $3 an hour. The average trip is four miles. Vehicles are operated, on average, 60 percent full. Speed is 25 miles an hour.

smaller vehicles. Overall journey time for a typical four-mile commute would drop from 23 minutes under the large-bus system to 15 minutes with small buses, and to 12 minutes with vans. These reductions, aggregated for all transit users, outweigh the more than 80 percent increase in operating costs for bus services themselves.

The lower costs of the more frequent services are not only of benefit to current transit users; they also greatly enlarge the potential market of riders for whom using transit services, as against driving in cars, is attractive. For all transit systems shown, overall costs of comparable car trips exceed those for bus services by large margins. But most of that additional cost is in the form of fixed ownership costs, averaged over the cars' useful lives. Typically, a car owner's decision to drive or take a bus would be based not on these fixed costs but on costs that vary according to the decision--vehicle operating costs, transit fares, and time and convenience factors. Automobile operating costs for the four-mile commute used in the transit examples, allowing an average of 1.5 riders per car, would be in the range of $30 to $33 for each 100 commuters, and transit-time costs would be unchanged from the transit estimates of $48 per 100.[4] This puts the in-vehicle journey cost for automobiles at around $80 per 100 riders--comparable to the equivalent cost for all the bus examples. Using or not using the bus would then be attractive, provided the increment of time spent waiting for a bus to arrive and then stop for other passengers was at least offset by the time and costs for collecting and depositing co-riders at both ends of a car trip and parking. If these latter costs were more than just 40 cents a car, automobile users would find small bus and van services less costly; large bus services, however, would not be so attractive as driving until collection and parking costs rose to around 90 cents a car--high enough so that in many cities, parking and pricing policies could be decisive in the choice. (*See Box 5, in Chapter V, for one example.*) Similar estimates assuming that all commuters could travel in four-passenger carpools show that frequent transit services are likely to be attractive if collection and parking costs are more than $2 a carload.

The calculations illustrated use a value of $3 an hour to compute time costs. But the lower overall costs for high-frequency systems still hold for much lower estimates of the economic worth of commuters' time. At 1984 transit operating costs and under the conditions in the example, for instance, U.S. transit systems would operate more efficiently with small vehicles if riders' time was valued above $1.00 an hour, which is less than one-third of the present federal minimum wage and well below time values typically used in feasibility studies for federally aided investments.[5] The potential market for whom frequent-service transit is less costly is thus very large and not restricted to more affluent groups in the community.

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[4] Estimates for automobile costs are taken from maintenance and fuel cost estimates for intermediate and compact cars. See Department of Transportation, *Cost of Owning and Operating Automobiles and Vans 1984*.

Under federal policy for aiding the modernization of existing transit systems, however, transit system development has tended to move away from, rather than closer to, networks of high-frequency services. During the last transit boom of the 1940s, one-fifth of buses added to the fleet seated fewer than 30 passengers and a further one-third offered between 30 and 40 seats. By contrast, 55,610 out of 63,280, or nearly 90 percent, of all the buses added between 1965 and 1983 have seated 40 people or more. Federal grants through 1982 have been approved for the purchase of 1,590 60-foot so-called "articulated" buses (in effect, double buses linked by flexible joints), and 44,000 40-foot buses. At the same time, only 8,000 small buses and vans have been bought. The average capacity of U.S. buses in 1983 (including standees) was 58 riders.

The trend toward increased bus size has tended to erode, rather than enhance, mass transit's attractiveness relative to private automobile travel. Physical limits on large buses in narrow suburban streets and low average loads relative to capacity on some routes have led to reduced coverage of transit networks and to route combinations with reduced frequencies. During the 1940s, 40 percent of municipal streets were bus routes; now, bus networks offer only half that coverage. Bus fleets were sized at one bus per 1.7 miles of network; now the ratio is one per 2.3 miles. This factor, combined with a 20 percent drop in annual mileage per bus, means that, on average, bus services are now 40 percent less frequent.[6]

Nationally, only some 6 percent of workers use any form of public transport on journeys to and from work (buses, only 4 percent)--but 70 percent of such transit use occurs in the central areas of large cities. In these cities' suburbs, transit use on work journeys dips to 5 percent; in smaller

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5. The Urban Mass Transportation Administration, for example, suggests a value of $3 an hour for transit studies, and FAA argues for time values equal to average earnings. On this basis the FAA used $17.50 an hour (in 1980 prices) in estimating benefits for air traffic control modernization. CBO's reevaluation of the National Airspace Plan used $5.90 an hour (30 percent of average earnings).

6. Estimates based on data compiled by the U.S. Bureau of the Census.

towns, less than 1 percent use public transit. (*Table 5 shows trends in ridership in cities of different sizes since 1940.*) The main corridors of larger cities, particularly to and from downtown areas, have been able to integrate the large buses without loss of business. (Measuring the changes is complicated by a change in statistical definitions.) Transit patronage in cities of more than 500,000 population, where public transit retains a dominant role for downtown work trips, seems to have remained at around the same level from the mid-1950s through the mid-1970s; thereafter, it seems to have increased somewhat. In smaller cities, however, ridership is now less than half that recorded at the beginning of the federal assistance program, and only one-ninth that of the 1940s boom years.

The Outlook for Transit Systems

Information on transit modes used for work journeys indicates considerable potential for the development of public systems based on frequent, convenient services allowing trips between many suburban origins and destinations. The use of shared transport (transit and carpools) is as high as or higher than in downtown travel outside central areas when journey speeds are comparable with those for car drivers (see Table 6).

But the pattern of regulation of transit activities and the cost structure that has evolved in the now largely publicly owned industry pose formidable barriers to improving the efficiency of mass transit. First, in response to pressure to limit demands for subsidy, transit officials will be led to favor the type of transit services with the lowest vehicle costs--that is, large buses. This is because industry studies indicate that, with fixed, subsidized fares, revenues from more frequent services would cover less than half the extra cost, and they would therefore require increased public support.[7] Further, the extent of the fare subsidy, now 64 percent of costs nationwide, restricts the pool of potential riders who value the time savings from more frequent transit services highly enough to be willing to pay more for them. Because the overall cost of longer journeys appears low to commuters, threshold time values for potential riders willing to switch from subsidized large buses to more frequent, self-financing services are double or even triple those for an unsubsidized system. As a result, transit agencies would not only have difficulty raising fares to cover costs but also new firms would be deterred by a much smaller potential market for

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7. See, for example, Econometrics, Incorporated, *Patronage Impacts of Changes in Transit Fares and Services* (Washington D.C.: U.S. Department of Transportation, September 3, 1980).

TABLE 5. TREND OF TRANSIT PASSENGER TRIPS CLASSIFIED BY POPULATION GROUPS, CALENDAR YEARS 1940-1983

		Surface Lines (In billions)						
Year	Heavy Rail	500,000 and Over	250,000-500,000	100,000-250,000	50,000-100,000	Less Than 50,000	Surburban and Other	Total Passenger Rides or Trips
				Total Passenger Rides [a]				
1940 [b]	2,382	5,611	1,710	1,329	967	379	719	13,098
1945	2,698	8,721	3,654	2,952	2,376	1,166	1,687	23,254
1950	2,264	6,649	2,563	2,024	1,689	930	1,126	17,246
1955	1,870	4,510	1,668	1,236	1,019	467	759	11,529
1960	1,850	3,865	1,175	891	714	297	603	9,395
1965	1,858	3,747	757	520	592	240	540	8,253
1970	1,881	3,265	662	428	494	175	428	7,332
1975 [c]	1,673	4,488	356	281	72	101	N.A.	6,972
				Unlinked Transit Passenger Trips [d]				
1980	2,108	5,206	409	310	90	112	N.A.	8,235
1981 [e]	2,094	5,158	301	242	91	78	N.A.	7,964
1982	2,115	4,934	286	238	90	78	N.A.	7,741
P 1983	2,167	5,050	276	231	89	76	N.A.	7,889

SOURCE: American Public Transit Association.

NOTES: N.A. = Not Available. P = Preliminary. Table excludes automated guideway transit, commuter railroad, and urban ferry boat.

a. Total Passenger Rides from 1940 through 1975 based upon individual transit system data collection procedures.
b. From 1940 through 1970 transit systems assigned by population of headquarters city.
c. From 1975 through 1980 transit systems assigned by population of urbanized area based on 1970 United States Census of Population.
d. Unlinked Transit Passenger Trips beginning in 1980 based on data collection procedures defined by Urban Mass Transportation Act, Section 15. Series not continuous between 1975 and 1980.
e. From 1981 through 1983 transit systems assigned by population of urbanized area based on 1980 United States Census of Population.

their services. In addition, most cities restrict entry to transport service sectors, often to protect their subsidized public agencies; by so doing, they limit the chances that competition could stimulate changes in the structure of services.

If bus systems were indeed efficient, road capacity--hence overall mobility for any combination of road and bus investment--would be greater than under the current system. Substitution of more small buses for fewer large ones would not necessarily increase road congestion. Smaller vehicles are less intrusive. They may make fewer stops and carry more passengers, so that passenger-car-equivalent measures of traffic flows may be equal. Moreover, studies have shown that the road space freed by attracting riders

TABLE 6. PROFILE OF JOURNEYS TO WORK BY MODE OF TRAVEL AND LOCAL POPULATION SIZE, 1980

Mode	In SMSAs a/ Central Cities	In SMSAs Outside Central Cities	Outside SMSAs	Total U.S.
Carpool				
Millions of Users	4.1	7.1	5.8	17.0
Speed (in miles per hour)	28.3	33.1	37.2	33.5
Public Transportation				
Millions of Users	4.0	1.8	0.2	5.9
Speed (in miles per hour)	12.6	18.1	19.0	14.7
All Shared Transport				
Millions of Users	8.1	8.9	6.0	22.9
Speed (in miles per hour)	18.5	28.3	36.3	26.6
Automobile, Sole Occupant				
Millions of Users	13.7	25.0	17.3	56.0
Speed (in miles per hour)	28.1	32.0	33.5	31.5
All Modes, Including Others Not Listed				
Millions of Users	23.5	35.8	25.3	84.7
Percent shared	34.0	25.0	24.0	27.0

SOURCE: Congressional Budget Office based on data provided by the U.S. Bureau of the Census.

a. Standard Metropolitan Statistical Areas.

from private cars to public transit generates new trips that tend to fill up the roads until the original "tolerable" congestion level is restored.[8] Without adding to delays for existing users, more frequent bus services, by attracting drivers out of their cars, free road space for new tripmakers. This is a clear gain in mobility.

Were transit efficient, fares would be higher, but services faster and more convenient. Moreover, cities could build fewer roads to accommodate any increase in traffic. But under current regulations, estimating the extent of this effect is difficult, because transit operators have no incentive to offer fast and frequent services in competition with the subsidized ones the cities provide. No market test of the value of increased trip making can be made to help in comparing mobility against transit and road costs. But simplified estimates indicate that the potential savings are large. If mass transit's share of urban travel had not declined during the 1970s, for example, urban road systems could (according to CBO estimates) have handled current traffic levels with something like $3 billion to $4 billion less a year (in 1983 prices) in capital investment.

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8. See Peat Marwick Mitchell & Co., *BART's First Five Years: Transportation and Travel Impacts* (Washington, D.C.: U.S. Department of Transportation and U.S. Department of Housing and Urban Development, April 1979).

CHAPTER V

INCENTIVES FOR USERS: THE ROLE OF PRICES

Beyond nomination and evaluation, a third important aspect of an infrastructure management system is the incentives the system provides to its participants. This chapter addresses the incentives provided to infrastructure users; the next examines the incentives to program managers.

An infrastructure management system may correctly nominate and evaluate projects, but it will not contribute to economic growth and productivity unless it provides the right signals to govern users' access to infrastructure facilities. Universal free access to roads, ports, or mass transit would lead to their overuse and rapid deterioration. Charging a price greatly in excess of costs would lead to underuse and reduce the productivity of the infrastructure investment. Thus, prices are the key to providing infrastructure users with the incentives to use facilities efficiently.

HOW PRICING CAN SHAPE DEMAND

Users influence the amount of infrastructure services provided through the demand they express. Demand influences options for system development in two ways. The first is simple wear and tear: the greater the demand on highways, for example, the sooner the highways will wear out. The second emerges in "spillovers," or interactions among users or between users and nonusers: for example, heavy congestion erodes the quality of transport service a highway offers. Further, users can raise the overall social cost of the system when, for example, use of a system causes pollution.

In managing the use of infrastructure services, pricing is a primary tool. Federal management systems that pay insufficient attention to how services are used and priced, that fail to encourage efficient internal organization of infrastructure agencies, or that are seen to provide earmarked independent sources of finance for certain agencies or programs can create incentives that work against program aims.

Infrastructure Pricing

If infrastructure investments are to reflect national priorities, the incentives the management system gives to users should reflect national goals.

While the attention of many analysts and decisionmakers regularly focuses on cost recovery--that is, on charging rates that can fully defray federal costs--a major concern from a managerial perspective is that the prices set encourage efficient use.[1] Efficient use results when the person deciding whether or not to use a given service values it at whatever it costs to provide the specific increment of service he or she seeks. If the price is too low, overuse will result, causing undue wear and tear, congestion, pollution, or all three combined. If the price is too high, facilities will lie idle, with resources diverted to purposes that are less desirable from a national perspective.

For pricing to promote national goals effectively, managers must take into account all costs associated with the use of services. Such costs have several dimensions. The midday driver, for example, imposes less cost than does the rush hour traveler, because of congestion and pollution differences. Car trips are less costly than truck trips because cars cause less wear and tear on pavement. Failing to charge for the spillover costs, or adjusting charges poorly for differences in costs among users, creates incentives that distort users' demands relative to their costs. Undercharging general aviation (mostly small aircraft), for instance, encourages overuse of airport facilities; this creates the appearance of need for new or larger airports. Overcharging, on the other hand, and thus charging more than the direct costs (including spillovers), suppresses demand that could otherwise pay for the resources used. The flat-rate cross-subsidy systems some managers favor in pricing such services as urban transit, for example, tend to raise prices above cost on those parts of the system where services are less costly or more attractive than competing services; they do so in order to subsidize below-cost prices on more costly, less competitive sectors. Such a pricing system thus tends to reduce use where it is most efficient, and to expand use where it is not. As a result, cross subsidization destroys the advantages of any service relative to those others offer.

Though the relationship between pricing to manage use and pricing to recover costs can be complex, in most cases practical difficulties are relatively minor. The complexity can arise because many infrastructure systems involve large capital investments. These high fixed costs are difficult to allocate to diverse users, and difficult to recover without unduly suppressing use. In practice, however, charging efficiently for all costs, including spillovers, will usually raise enough revenue to recover high capital investment costs--so long as managers do not overbuild. Scale economies that might otherwise make it difficult to recover capital costs from users

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1. For analysis of potential cost recovery for seven infrastructure services, see Congressional Budget Office, *Charging for Federal Services* (December 1983).

are fairly quickly eaten up by rising costs from congestion among users or other spillovers. In most infrastructure systems, the price that promotes efficient use (that is, the price that recovers the overall costs, including spillovers, of the last unit of service) is then also sufficient to recover the cost of operations and upkeep that the infrastructure agency incurs. Thus, the principle that prices should encourage efficient use is generally not inconsistent with the equity principle that users pay that is embodied in the cost-recovery principle.

A special case occurs if investment mistakes have resulted in overbuilding. Then, requiring a sound financial position for the agency charged with managing or operating a system--say, a port or turnpike authority--may necessitate charging users more than the price that maximizes the efficient use of the assets. The alternative would be to provide direct subsidies to cover revenue shortfalls. Both courses risk inefficiencies--on the one hand, those of suppressing or diverting use to other systems through overcharging, and on the other of administrative inefficiencies arising because of slacker cost management in subsidized agencies. Pricing in that case might follow "second best" rules, which attempt to apportion overhead costs among different users and services in ways that minimize distortions from the goal of efficient use of facilities.

A general difficulty in making optimal use of pricing for managing infrastructure systems is that prices in the public sector are generally more closely scrutinized and less responsive to changing market conditions than are prices in private markets. Public sector pricing usually requires elaborate procedures for setting costs, undergoing review, and receiving approval. The costs of making and changing prices for infrastructure services are not trivial, and changes in both the level and structure of these prices are usually infrequent. (*Table 7 shows how user fees are applied in federally supported infrastructure programs.*) In few programs have user fees (levied at all governmental levels) thus far assisted in infrastructure priority setting.

Reflecting Costs in Prices. The structure of highway taxes comes closest to a comprehensive price system, in that it attempts to relate taxes paid to the extent of actual use and to the extent of road damage resulting from that use. But current practice also undertaxes heavy trucks (those above 55,000 pounds gross vehicle weight) for the road damage costs they cause.[2] It also ignores large spillover costs to other drivers, particularly

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2. Comparisons of highway excise tax payments relative to allocable highway costs, including an option labeled DOT4 that is similar to the tax structure subsequently enacted in the Highway Revenue Act of 1984, are given in U.S. Department of Transportation, *Alternatives to Tax on Use of Heavy Trucks* (January 1984).

TABLE 7. CURRENT USER FEE OBJECTIVES IN FEDERALLY AIDED INFRASTRUCTURE PROGRAMS

	User Fee Objectives					
Program	Recover Federal Costs a/	Recover Total Government Costs b/	Recover Spillover Costs c/	Fees Varying With Use d/	Low Fees e/	No Fees f/
Highways	X	X	X	X	--	--
Airports	X	X	--	--	--	--
Air Traffic Control	--	--	--	--	X	--
Conrail	--	X	--	X	--	--
Amtrak	--	--	--	--	X	--
Coast Guard	--	--	--	--	--	X
Ports	--	X	--	X	--	--
Inland Waterways	--	--	--	--	X	--
Mass Transit	--	--	--	--	X	--
Municipal Water	--	X	--	X	--	--
Multipurpose Dams	--	--	--	--	X	--
Wastewater	--	X	--	X	--	--

SOURCE: Congressional Budget Office.

NOTES: All objectives categories refer to specific taxes levied on users rather than to general revenue sources applied to program financing.

a. Fees levied are tied directly to federal program levels.

b. Besides any federal levies, fees are charged by state or local authorities to recover their costs. Most such activities are managed by public authorities or public corporations.

c. Reflect the costs imposed by users on other users, or by users on nonusers.

d. Fees set so that users' payments reflect their overall consumption of the services.

c. Fees deliberately set to subsidize use. This category is the converse of column b/.

f. Neither federal nor local agencies levy fees for the use of these services.

those who contend with congested traffic. It may also rely too much on annual taxes (registration fees) or one-time taxes (on vehicle purchases) to be effective in influencing automobile use in particular, and too much on systemwide collections to influence use of particular facilities, especially urban streets.[3]

User fees in the form of tolls may sometimes bring road prices closer to the comprehensive cost level.[4] The costs imposed by automobiles on congested urban streets, in terms of the delays imposed on other drivers and pollution from exhaust emissions for example, can be around 10 to 20 times the gas-tax rate.[5] But these high costs would apply only on limited corridors and at certain times. Toll-based rather than tax-based prices can more easily be tailored to reflect such cost variations.

Among public enterprises, only two apply enterprise-like pricing policies: Conrail, operating in the newly competitive long-distance freight market, and ports, feeling the impact of competition through changes in trade patterns and cargo volumes. Conrail operates as a firm in the marketplace. Ports invite firms (shipping companies, terminal operators, freight forwarders) to provide services in different areas of the port in competition with each other, with each in turn charging for the services it provides to ship and cargo owners. Rents and general charges on shipping, meanwhile, usually cover port authority overheads. By contrast, in the federal irrigation schemes in western states, prices are typically fixed in long-term contracts at amounts that will recover around one-tenth of supply costs.[6]

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3. Evidence on this latter point has been assembled by the Urban Mass Transportation Administration Technical Assistance program, which has sponsored special programs for encouraging use of high occupancy vehicles by favorable parking pricing schemes. See Urban Mass Transportation Administration, *Parking Pricing Management*, Washington, D.C. (October 1984).

4. For consideration of other aspects of toll financing, see Congressional Budget Office, *Toll Financing for U.S. Highways* (December 1985).

5. A 40-minute car commute, for example, that off-peak could be undertaken in 20 minutes, say, would consume about 0.9 gallons of gasoline, for an average tax payment (state and federal) of just over 17 cents. The 20-minute delay assuming 1.5 occupants, would cost between $1.50 and $2.50 at values of time between $3 and $5 an hour. Ratios of waiting time to gas taxes would then be between 9:1 and 15:1.

6. The Reclamation Reform Act of 1982 (Public Law 97-293) provides that water districts that do not renegotiate contracts by March 1987 will face paying fees that recover full federal cost for water delivered to farms larger than 160 acres (320 for a married farm couple). Renegotiation, however, would allow districts to deliver water at current rates to farms up to 960 acres. The overall effect on water prices is thus unclear.

An Example of Spillovers: "Congestion Pricing"

Airports are another example. The value of landing slots varies with time of day. Landings at the most popular times are valuable because they make the best use of travelers' time. At some airports, airlines wish to operate more flights at these times than airports can handle efficiently. But airport pricing typically does not consider this.[7] Because airport fees do not ration slots, the Federal Aviation Administration enforced during the 1984-1985 winter a system of capacity quotas at the six busiest airports, under which airlines and other carriers were assigned arrival and departure times during peak operations.

Studies have shown, however, that infrastructure is more efficiently used when its use is regulated through pricing rather than quotas. In airports, the gain in efficiency results because flights that value certain arrival or departure times are able to outbid flights for which other times or even other airports (in the case of transferring traffic, for example) are equally suitable. Thus, the limited peak capacity is made available to the most valuable operations.[8] A study of FAA quotas at St. Louis in 1981, for example, shows that centralized allocation of slots has increased the losses from flight cancellations caused by capacity restrictions by between $7 million and $25 million a year (in 1981 dollars), depending on policies for allowing new entrant airlines access to peak times, over those that would have occurred if slot trading had been allowed.[9] Further, the study shows substantial costs to air transport that would remain after slot trading of about $12 million a year compared with costs without capacity limits. In other words, airlines would be prepared to pay $12 million for extra flights at the restricted times, an effect completely masked by quotas. Prices set to manage use, therefore, provide reliable signals on when expanding capacity is needed. In the St. Louis case, investing up to $85 million in capacity expansion would be economically justified, if capacity limits were permanent.[10] In Singapore, however, a system of permits, fees, and other mechanisms was devised to deal with peak-hour road conjestion (see Box 7).

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[7] From April 1, 1986, DOT rules permit some slot trading of Washington's National Airport, New York's La Guardia and John F. Kennedy Airports, and Chicago's O'Hare Airport. The appropriateness of this trading is to be debated in the Congress.

[8] If slots were sold to the highest bidder, some small and medium-sized communities may lose air service because airlines serving them are unable to acquire slots at destination airports. In that case, it may be more efficient to sell slots in separate pools that assure that these communities continue to receive service, if a market based pricing system were established. See, for example, Severin Borenstein, *On the Efficiency of Competitive Markets for Operating Licences*, Institute for Policy Studies Discussion Paper No. 226 (Ann Arbor: The University of Michigan, September 1985).

[9] Donald Koran and Jonathan D. Ogur, *Airport Access Problems: Lessons Learned from Slot Regulations by the FAA, An Economic Policy Analysis*, Bureau of Economics, Staff Report to the Federal Trade Commission (May 1983).

The failure to use pricing as a tool for U.S. infrastructure management seems inconsistent with the rationale for public support for provision of the services. The persistent failure to incorporate spillover effects in pricing illustrates the types of inefficient choices made attractive by inadequate pricing. When ports and airports fail to use pricing systems that encourage ships and aircraft to employ facilities in the sequence that reflects the value of the terminal services to them, it raises handling costs and inflates apparent investment needs. Further, if pollution control costs are not included in prices charged, prices for some goods will generally be lower than the system cost, including pollution damage. As a result, the production of the goods with polluting side effects is encouraged relative to nonpolluting activities, and the apparent need for pollution-control measures expands. This last effect is particularly evident when one compares progress made during the 1970s in controlling air pollution through a system of internalizing more spillover costs through lower subsidies for emission control devices, with the outstanding backlog of about half the wastewater treatment plants originally estimated as needed under a subsidy scheme operating in the same period that allowed communities virtually to escape costs. Thus, regulation can be an efficient substitute for capital programs in inducing users to take account of external costs in choosing their uses of infrastructure when these are difficult to price.

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10. The benefit of avoiding the $12 million a year cost for canceling 85 flights and rescheduling other flights to meet capacity restrictions would provide a 12 percent return on an $85 million investment with a 15-year life. Minimum losses under the quota system of $19 million a year would appear to justify a $140 million investment at the same 12 percent return.

BOX 7
PRICING INFRASTRUCTURE USE--ROAD PRICING IN SINGAPORE

Since June 1975, entry to Singapore's main downtown area during the morning rush hour has been restricted to buses and drivers displaying special licenses. The licensing scheme was introduced to avert the burgeoning of severe congestion in the main business and shopping district. Its introduction was preceded by a year-long public information program, and was supplemented by steep increases in parking fees and the availability of park-and-ride services based on new fringe area parking lots. In the first year, all morning traffic was reduced by 40 percent with automobiles down 70 percent. Vehicle occupancies increased significantly, while bus transit improved its share of commuters from 33 percent to 46 percent; about half of the cars entering downtown carried four or more passengers instead of just one. The scheme also had the effect of stretching the peak period and diverting through traffic. Air pollution and safety risks fell, and the license system has been judged to have had positive environmental effects.

National effects were also positive. To date, the scheme is a financial success. Revenues from license sales are enough to cover all operating costs and provide a net return of about 10 percent on the small investment made (just under $3 million, spent mainly for fringe-area parking lots). At the same time, the overall growth in gasoline consumption has fallen from 6.4 percent annually between 1970 and 1975 to 3.8 percent a year.

Managers of the licensing scheme have confronted three important issues. First, without a precedent, planners faced the risk that the fee they chose would be too high or too low. Initially, it did indeed prove to be higher than needed. Planners had aimed to set license fees to reduce peak-hour traffic by 25 percent to 30 percent, including a 50 percent reduction in automobiles. This would have equated peak and off-peak flows. The scheme far exceeded this objective. During the scheme's first several years, downtown streets were significantly underused. Managers judged, however, that long-term changes in attitudes toward automobile commuting were more important than short-term efficiency gains, and they did not lower the fee. As inflation eroded the effect of the fee, downtown streets absorbed a 24 percent increase in automobile traffic between 1975 and 1980 without exceeding the scheme's traffic-management objectives.

Second, probably because of substantially different trip purposes, reductions in the morning rush hour (principally journeys to work) were not matched by lower evening peaks, which include a substantial proportion of trips for shopping, dining, and other leisure purposes. Without harming businesses in the downtown area, however, there seemed to be no way of imposing restraints on evening traffic, and no solution was found.

Finally, though readily accepting public transit and carpools, Singaporeans made little use of the park-and-ride services. Occupancy of the parking lots was as low as 6 percent. Shuttle buses were quickly redeployed to supplement mainline services, and alternative uses found for the land devoted to carparks.

SOURCE: For further information, see Peter L. Watson and Edward P. Holland, *Relieving Traffic Congestion: The Singapore Area Licensing Scheme*, World Bank Staff Working Paper no. 281 (Washington, D.C., June 1978), and The World Bank, *World Development Report 1981* (New York: Oxford University Press, August 1981).

CHAPTER VI

INCENTIVES FOR MANAGERS:
PROMOTING NATIONAL GOALS

This chapter discusses the incentives that the federal infrastructure management system provides for program managers. Federal and local managers often have few incentives to manage infrastructure programs in ways that further national goals. Federal managers responsible for the broad shape and coverage of programs rarely adapt their programs to changing conditions, nor do they make real trade-offs between existing programs and new opportunities. Thus, while circumstances change, many federal programs remain static.

On another level, federal aid provides state and local infrastructure managers with two important incentives. First, nonfederal governments tend to regard federal grants-in-aid as generally similar to their own, nonfederal, revenues, and therefore, have the incentive to substitute them for their own resources. Thus, the increase in infrastructure spending that follows federal aid is commonly much less than the amount of that aid, because states and localities do not expand their spending by the added amount. Second, important federal subsidies are provided through tax exemptions for local borrowing to finance projects, and though investments financed this way usually involve careful attention to project choices, states and localities--not federal managers--have control over the sizes of the subsidies and the nature of the projects financed, and may have little incentive to use this subsidy to meet national objectives.

MANAGING PROGRAM EVOLUTION

Federal infrastructure management policies must offer program managers incentives to change programs as new circumstances require. Most infrastructure programs are of long duration, and their managements must therefore be responsive to changing community needs and issues. (*A Canadian initiative for encouraging innovation in government programs is described in Box 8.*) At first sight, the federal highway program appears to have been much more innovative than other programs. Activities

BOX 8

INCENTIVES FOR PROGRAM MANAGERS--CANADA'S ENVELOPES FOR POLICY AND EXPENDITURE MANAGEMENT

The government of Canada developed an "envelope" system for controlling expenditures that forces bids for capital investment to vie directly against one another. The envelope system effectively separates expenditure control from policy development. The former is exercised in scrutiny by the Treasury Board (comparable to the Office of Management and Budget) of spending under approved programs; the latter is managed by sectoral policy committees of the Cabinet. All projects proposed for financing from the policy reserve are examined first by the Treasury Board, then by a policy committee's professional staff, which independently analyzes proposals competing for limited policy reserve funding. Cabinet ministers then rank new proposals, approving those of greatest rank, until the policy reserve is exhausted. The bases on which plans compete are their identifications of needs, analyses of options, and appraisals of investments.

All governmental programs are grouped into policy sectors, and each sector is assigned a limited total, or envelope, of resources. Allocation of resources within each policy sector is managed by a committee of the Cabinet. Envelopes normally include a current policy level (or A-base) budget and a policy reserve (the B-base) of around 10 percent for new initiatives, including capital projects. Departments within any sectors assigned a negative policy reserve

attracting federal highway assistance have broadened and changed over time. Federal activities in aviation or water resources, however, are now broadly the same as they were in 1960. The highway program has incorporated three entirely new initiatives for federal assistance--highway and traffic safety in 1966, bridge reconstruction in 1972, and rehabilitation of state and local networks in 1974 and of the Interstate system in 1976. [1]

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[1] Highway and traffic safety programs were first included in Public Law 89-563; the bridge reconstruction program dates from Public Law 91-605; aid for rehabilitation of state and local networks was just authorized under Public Law 93-643; and aid for resurfacing of interstate highways more than five years old dates from Public Law 94-280.

must prepare X-budgets detailing program reductions and efficiencies that will reconcile expenditures and resource envelopes.

Efficiencies and reductions of scale in current programs also increase the policy reserve available for new projects. This has encouraged ongoing assessments of priorities, benefits, and costs of existing and proposed policies and programs within each policy sector. Several departments with positive policy reserves have submitted X-budgets to increase the resources available for capital projects.

Each capital project of more than $1 million (Canadian) requires clearance by the Treasury Board before submission for Cabinet approval. For any proposal, the Treasury Board requires several clear statements: whether the project is an operational need or a response to congestion; how much it would cost; and how well does it hold up under analysis of benefits and costs, of cost effectiveness, or of other economic or efficiency factors. Final approval depends on highly detailed cost estimates based on vendors' bid prices. Any cost overrun that develops after approval must be financed from the A-base budget, not from the policy reserve.

SOURCE: Analysis prepared for CBO by James F. Hickling Management Consultants Limited, *Capital Management Abroad,* Study for the Congressional Budget Office, Ottowa, Canada (May 1984), and Congressional Budget Office, *Tax Expenditures: Budget Control Options and Five-Year Budget Projections for Fiscal Years 1983-1987* (November 1982).

On closer scrutiny, program changes have thinned the federal commitment to each component, rather than to substitute new for old priorities. Federal spending on highway programs is only slightly higher now (after correcting for price changes) than it was in 1970 or even 1960. In general terms, the three new program areas have largely diluted Interstate construction activity, while the broad categories of activities of the Federal-Aid highway program have expanded at the expense of special or demonstration projects. This latter group is currently less than 2 percent of federal spending for highways. But while substituting new activities for existing ones in principle implies comparisons of their relative importance, evidence that this has occurred in highway program management is mixed. In fact, as the following section discusses, the use of trust funds in general has impeded the evolution of programs.

Trust Fund Financing

Debate on the 1966 Safety Acts covered the then controversial proposal that safety programs should be financed from the Highway Trust Fund. The effect of delaying completion of the Interstate network by about two years was a matter of concern. Since 1966, however, the completion date for the Interstate system has slipped a further 18 years to 1990, largely because other initiatives in highway financing seem simply to have diluted, rather than substituted for, ongoing activities. Much of the dilution results from the desire of program proponents to insulate their programs from line-item competition with other programs and to assure a steady source of revenue from the Trust Fund. Thus, while infrastructure managers have often used trust fund mechanisms to isolate their programs from general budgetary pressures, recent experience with the highway program suggests that the assured source of revenue for the fund also attracts a variety of only partly related programs that detract from achieving the fund's original goals.

An important advantage to trust funds--if the level of contributed taxes is set with regard to financial and efficiency goals--is good control in a program's financial management. Tight financial controls on the Highway Trust Fund, taking four forms, emphasize the direct link between spending and resources:

- The Byrd amendment, which prohibited annual deficits in the fund during 1956 to 1982, and the current procedures for projecting revenue shortfalls;
- The clear policy statement that no general revenue taxes should be used on the highways, and that taxes on highway users should be distributed fairly;
- The reconciliation process established under the Budget Act of 1974; and
- Annual obligation ceilings imposed routinely since 1975. 2/

The restriction on annual deficits and revenue sources, as well as obligation ceilings, have been effective in fostering dual attention to appropriations and tax revenues. Because of the shorter lapses now intervening between the last year of authorization of trust fund programs and the

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2. The first of these features dates from the Highway Revenue Act of 1956, and the second from the Highway Revenue Act of 1982. The policy of avoiding general deficits and fair taxation dates from the 1956 Act. Obligation ceilings on highway spending are set out in the Appropriations Act for the Department of Transportation in each year since 1975.

scheduled expiration date of the fund, the restriction on overall deficits in the fund now commonly leads to simultaneous consideration of program authorizations and tax or revenue issues. Trust fund programs are now authorized through 1986, and the trust fund itself is scheduled to expire in 1988, so that only two years' revenues are available to cover any gap between authorizations and income. When just established in 1956, however, the Highway Trust Fund had a scheduled life of 15 years, but programs were fully authorized for only three years, so that the effect of the restriction on overall deficits on spending was not severe.

In important instances, particularly when management efficiency can be improved, tight financial controls can be the preferred strategy. Better choices among development options tend to be made if rewards for good decisions and consequences for bad ones accrue to program managers than if managers are able to call on public subsidies to cover mistakes. In some cases, financial self-sufficiency as an agency goal (which may sometimes require fees to cover capital and overhead costs) can be more important to orderly infrastructure management than are strict efficiency goals in pricing. Trust funds are a way of imposing this discipline on programs not managed by enterprises.

The administrative advantages of trust funds, however, have to be balanced against other aspects tending to detract from program efficiency. In all trust funds, program financing needs have dominated consideration of pricing policies and taxation rates, so that serious issues of cross-subsidy have arisen among trust fund contributors, and between contributors and other infrastructure users. Finance shortfalls have led to increases in earmarked tax rates without regard to the broad priority for investments to be financed relative to other programs. The efficiency of the investments financed by the funds and even the priorities for investments in different sectors of the industry are jeopardized by these distortions.

Contributors, too--though sometimes willing to pay added taxes--demand that all tax revenues, including those from new or increased rates, be spent on their programs. The level of investment therefore tends to be determined by the rate of taxation, and not by the relative costs and benefits of new or expanded infrastructure, and equally not by the relative national priorities for trust-fund-financed and other infrastructure programs. Infrastructure investments are irregular, generally occurring periodically and in large amounts, whereas tax revenues follow more regular trends reflecting changes in activity levels or tax rates. Trust fund programs therefore tend to underfinance at critical periods and to even out investment rates by financing delayed projects at higher cost later on. Financing reasons, for example, were and remain the principal motives for extending target completion of the Interstate highway network to 1990.

Pressure to spend surpluses is apparent in the airport and the transit funds. Barge officials seek guarantees that the revenues from barge fuel taxes will be spent only on the waterways, even though revenues cover only 10 percent of projected spending. Trust funds encourage users to demand the dedication of the fees they pay to programs for new facility construction. Thus, they impede proper consideration of the appropriate level of investment in each activity, of trade-offs among different types of investment, and even of the proper balance to be sought in capital and maintenance activities when only one is subject to trust fund financing.

Hence, Congressional discretion on the balance between different programs is severely constrained by a predetermined mix of earmarked and general tax revenues available. Most of the time, the trust funds used in infrastructure programs seem to dilute and confuse issues for program management, thus they seem to make changes in program direction difficult to implement.

INCENTIVES FOR STATE AND LOCAL AGENCIES

Rather than reduce the nationwide sum of resources needed to implement projects, federal aid to states and localities redistributes costs among different groups in the nation. National measures of resources should properly influence priorities. But perceptions of the costs and benefits that flow from different courses of action differ at federal and local levels. (*Box 9 describes efforts in state agencies to alter choices to favor agency goals.*) Without aid, local choices could be expected to favor projects with the most local benefits and/or the least local costs, without reference to effects on outsiders. Local infrastructure agencies can be expected to favor choices furthering their own interests, sometimes without reference to overall state or local impacts, especially if relatively financially independent. To achieve its aim, therefore, the offer of federal aid must be organized in such a way as to eliminate the incentive to favor local rather than national solutions. [3]

Federal aid for highway construction, as an example, lowers local costs of providing for through traffic and improves the local attractiveness of these projects relative to improvements on local roads. More Interstate highways will be constructed than the states would otherwise fund. But the extra highway miles are constructed at the expense of unaided projects

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[3] Categorical federal aid alters state and local choices through two effects. First, by lowering the local costs of projects in aided categories, states are encouraged to spend more than they would on those projects. Second, by increasing overall resources available, states are encouraged to spend more on all projects, including those in the aided group.

BOX 9

AGENCY STRATEGIC PLANNING-- MAKING CHOICES IN NEW YORK, NEW JERSEY, AND PENNSYLVANIA

"Strategic planning," the public sector's version of corporate planning, has helped agencies redefine their roles and set new directions. Public managers, though usually not so free as corporations to set new objectives, often have wide discretion on the interpretation of goals and how to pursue them. In both the Pennsylvania Department of Transportation (a traditional state agency) and the Port Authority of New York and New Jersey (serving two states), strategic planning has been integrated with agencies' annual budget processes.

Both these bodies introduced strategic planning by identifying activity areas consistent not only with wide-ranging reviews of opportunities for the future but also with their own agency abilities. Each identified four priority activities. The Port Authority review revealed two new ventures and two traditional activities important to its goal of economic development. In Pennsylvania, a different emphasis emerged on the role and focus of the department's traditional activities.

In both cases, the activities identified cut across the institutions' functional lines. Both revised their management systems to reflect new mixes of interests. Pennsylvania introduced seven strategic subcommittees of upper-level managers reporting to top management's strategic management committee. The former set and review policies and goals as problem-solving groups not representing their line management functions but rather in an advisory peer review capacity. In the Port Authority, line departments must submit (or have prescribed for them) performance targets and "sunset" (expiration date) conditions for each activity undertaken, so that managerial and budgetary review can formally monitor and compare progress toward objectives.

From routinely reviewing goals and progress, both the Port Authority and the Pennsylvania DOT report significant gains. Line managers develop a much broader view of the agencies' aims, and thus they generate a much wider range of options for action. Views of agency responsibilities as simply conservation of physical assets have been discarded. Instead, agency divisions have come to see themselves as part of their communities' activities and have been able to develop system approaches to service development. By clarifying links between mandated objectives and services to users, the agencies have become more responsive to both.

within and outside highway programs because the federal assistance requires local matches, and local authorities raise these sums by canceling other projects or by increasing taxes. In an ideal case, then, the availability of highway assistance would be managed to encourage replacement of all locally preferred projects of lower national worth than national trade routes, but in such a way as to prevent its use to build unjustified road segments or segments with lower value than projects displaced. Federal aid attempts to achieve this by both lowering the prices of favored activities (through matching shares), and by increasing resources available through grants-in-aid. Incentives for project choices are thus provided as much through the eligibility conditions applied to federal matching grants as through the amount of federal financial aid.

Federal Capital Grants--Stimulus or Substitute?

Up to 60 percent to 70 percent of federal aid now exerts little influence on local choices for infrastructure improvements. States and localities substitute up to this proportion of federal grants for their local tax revenues and increase the overall spending in response to federal programs by only around 30 percent. In other words, were federal infrastructure aid to be substantially reduced, then states and local governments would face local pressure to raise taxes to finance projects now financed federally. In the long run, national infrastructure spending would probably change by much less than any federal cut.

Whether federal grants have stimulated state expenditures, or merely substituted for them, can be determined by looking at the increment of spending on federally assisted activities. An 80 percent federal match, for example, reduces the local cost for an infrastructure facility aided to one-fifth the cost of another, unsubsidized project. As a result, local officials can be expected to alter their own budgetary priorities to emphasize subsidized projects and put aside ones for which they would bear the full costs. Such adjustments would develop slowly, because of the increases in state or local resources needed to match federal funds. In simple arithmetic terms, the upper limit to such stimulated spending is reached when additional projects have an overall cost equal to the inverse of the matching share times the federal amount. For an 80 percent federal share, for example, the maximum total additional spending attributable to the federal leverage would be one-fourth again the amount of the federal outlays (1 divided by 0.8 equals 125 percent). At this 125 percent level, the new local budget would include all projects originally selected by local agencies, plus additional projects to the maximum extent of federal aid. A ratio greater than one but less than the inverse of the matching share indicates that some new projects are undertaken but also that some federal aid is being used for projects that local officials would implement without a subsidy. A ratio of one or less indicates that federal spending has simply replaced more state funds. In this case, the value of the additional projects undertaken is less than the amount of federal aid.

Eleven studies measuring these effects for different federal programs have produced generally consistent findings (see Table 8). Although numerical results differ somewhat because of analytic distinctions, the studies concur that--apart from highway construction activity, for which something near the maximum stimulation might have occurred--federal investment grants have largely substituted for part of state and/or local spending. This is emphasized in the different results in those studies of the highway program covering the decade when half of the Interstate construction program was completed and those studying highway federal grants for ABC highways on state and local networks.[4] Between 1958 and 1966, federal highway aid overall broadly stimulated state highway spending, but federal programs assisting non-Interstate systems, during this period and after it, have been found to substitute partly for state spending.[5] Further, the more recent studies indicate that the extent of the substitution may have increased.

The general substitution of federal for nonfederal capital in infrastructure programs can be seen in the decline in state and local capital formation since 1975, a period when federal spending was increasing (see Figure 4). Further evidence is in the difficulty in devising objective tests of financing prospects. Of the projects presented, 93 percent pass the federal test--that is, without federal Urban Development Action Grant support, they would not be undertaken, even though as many as one-third are demonstrable substitutes for other investments.[6]

The management implication of the high degree to which states and localities substitute federal aid for part of their own resources is that federal infrastructure policies exert much less influence on nonfederal priorities than the 50 percent federal share of capital financing would imply. This suggests that the priorities for infrastructure development in state and local budgets could be better attuned to national priorities and goals by changes in the amounts and costs of federal aid.

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4. The ABC highway network is the first federally assisted network and covers, A--primary highways, B--secondary highways, and C--urban extensions of these two.

5. Compare for example the results in Table 8 of Thomas O'Brien, with those of Edward Miller and Harry G. Meyers.

6. See Congressional Budget Office, *The Federal Government in a Federal System: Current Inter-Governmental Programs & Options for Change* (August 1983).

TABLE 8. STIMULATION AND SUBSTITUTION EFFECTS OF FEDERAL GRANTS FOR CAPITAL PROGRAMS FOUND BY ELEVEN STUDIES

Study	Mode	Years	Total Additional Spending per Dollar of Federal Aid		Principal Effect of Federal Aid	Remarks
			Maximum	Actual		
Pogue & Sgontz a/	Highways	1958–1965	1.25–1.75	1.65	Stimulative	Maximum ratio based on program mix.
Smith b/	Highways	1965	1.25	0.17	Substitutive	Single year variations in spending may mask underlying responses to grants.
Osman c/	Highways	1960	1.32	1.37	Stimulative	See note above.
O'Brien d/	Education	1958–1966	N.A.	2.64	Stimulative	No fixed match.
	Highways	1958–1966	1.25–1.75	1.06	Stimulative	
	Health & Hospitals	1958–1966	N.A.	1.67	Stimulative	No fixed match.
	All Programs	1958–1966	N.A.	1.52	Stimulative	
Miller e/	ABC Highways	1960–1969	2.00	Not Estimated	Substitutive	The study shows variations among states. Federal grants stimulated spending in thinly populated western states receiving 15 percent of federal aid.

(Continued)

TABLE 8. Continued

Study	Mode	Years	Total Additional Spending per $1.00 Federal Aid		Principal Effect of Federal Aid	Remarks
			Maximum	Actual		
Sherman f/	Interstate Construction	1957-1970	1.11	1.62	Stimulative	--
	Primary Highways	1957-1970	2.00	Negligible	Substitutive	--
	Secondary Highways	1957-1970	2.00	Negligible	Substitutive	--
Irwin g/	Highways	1951-1968	1.25-2.00	0.53	Substitutive	--
Consad h/	Interstate Construction	1957-1977	1.11	1.08	Stimulative	The ratio for interstate construction is high relative to the maximum feasible of 1.11. Study authors caution that it may be biased upward.
	ABC Highways	1957-1977	1.43-2.00	1.08	Stimulative	The study does not separate highway programs.
	Wastewater	1957-1977	1.33-2.00	0.60	Substitutive	--
	Mass Transit	1957-1977	1.25-1.51	0.75	Substitutive	--
Gramlich i/	Categorical Grants	1946-1981	N.A.	0.38	Substitutive	The study covers all state and local expenditures. Results shown relate to nonconstruction spending.
	Block Grants	1946-1981	N.A.	0.20	Substitutive	--

(Continued)

TABLE 8. Continued

Study	Mode	Years	Total Additional Spending per $1.00 Federal Aid: Maximum	Total Additional Spending per $1.00 Federal Aid: Actual	Principal Effect of Federal Aid	Remarks
Jondrow & Levy [j]	Wastewater	1949-1981	3.33-1.33	0.33	Substitutive	The study also found a temporary displacement effect. For each $1.00 in unspent federal budget authority municipalities postpone $0.28 of capital construction anticipating grant approval.
Meyers [k]	ABCD Highways	1976-1982	1.33-1.42	0.37	Substitutive	The study indicates that nonfederal funds freed by the substitution of federal funds remain in highway budgets.

SOURCE: Congressional Budget Office from studies noted below.

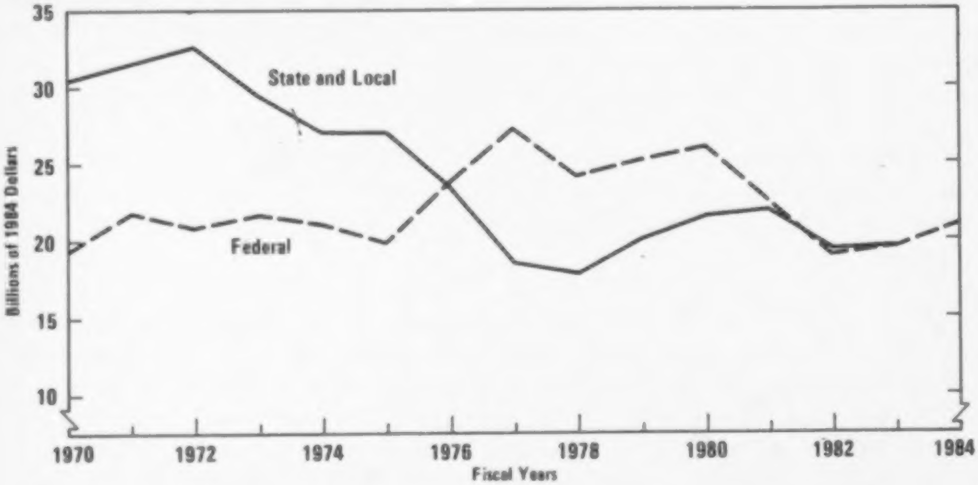
NOTES: N.A. = Not Available; the effective federal match in these cases cannot be estimated reliably.

The term "stimulative" is used when additional spending is at least equal to the federal contribution. The term "substitutive" indicates that additional spending is less than the federal finance provided. In all cases, however, total spending by all levels of government is shown to increase.

[a] Thomas Pogue and L.G. Sgontz, "The Effects of Grants in Aid on State-Local Spending," *National Tax Journal*, June 1968.
[b] David Smith, "The Response of State and Local Governments to Federal Grants," *National Tax Journal*, September 1968.
[c] Jack Osman, "On the Use of Intergovernmental Aid as an Expenditure Determinant," *National Tax Journal*, December 1966.
[d] Thomas O'Brien, "Grants-in-Aid: Some Further Answers," *National Tax Journal*, March 1971.
[e] Edward Miller, "The Economics of Matching Grants, *National Tax Journal*, June 1974.
[f] Leonard Sherman, "Impacts of the Federal-Aid Highway Program on State and Local Highway Spending," Doctoral Dissertation, Massachusetts Institute of Technology, 1975.
[g] Laura Irwin, *Expenditure Effects of Federal-Aid: Data Aggregation and the Risk of Uncertainty*, Publius, vol. 5, Fall, 1975.
[h] Consad Research Corporation, *A Study of Public Works Investment in the United States*, U.S. Department of Commerce, April 1980.
[i] Edward M. Gramlich, *An Econometric Examination of the New Federalism*, Brookings Papers on Economic Activity, 2:1982.
[j] James Jondrow and Robert A. Levy, "The Displacement of Local Spending for Pollution Control by Federal Construction Grants, *American Economic Review*, vol. 74, no. 2, May 1984.
[k] Harry G. Meyers, *Displacement Effects of Federal Grants for the Primary, Secondary and Urban Federal Aid Highway Systems*, Office of Management and Budget, Special Studies Division, July 1985.

Figure 4.

Federal and Nonfederal Capital Spending on Public Works Infrastructure, 1970-1984



SOURCE: Congressional Budget Office.

How would changing the federal aid mix of categorical, block, and untied grants tend to alter the shares of investment and recurrent spending in public sector budgets? Some study results indicate the difference between lump-sum block grants and the program-by-program categorical grants has little effect on nonfederal investment decisions. [7] This could mean that the numerous divisions in the Federal Aid highway program, for example, have little influence on the mix of projects in states' lists for highway spending. A further result estimates that states would be willing to accept 10 percent to 15 percent less in federal aid if it were provided as untied grants or general revenue rather than as categorical or block grants associated with particular programs.[8] The Department of Commerce's study of public works investment concludes that, during the 1970s, states and cities together have used about one-third of general revenue assistance for public investments--states generally less than 20 percent, but cities--particularly medium-sized and small ones--sometimes up to 50 percent and more.[9] At the higher ranges, these are not much lower than the ratios of additional spending per federal dollar reported in the same study (also shown in Table 7) for typical urban investments (wastewater 60 percent and transit 75 percent), particularly taking into account that smaller amounts of untied aid can be substituted. Thus, while untied aid could be as effective a federal strategy for assisting cities, for states and large metropolitan areas, either categorical or block grants may be preferable for promoting public investment.

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[7] Gramlich, op. cit.

The opportunity for substitution arises when aid is made available for activities for which state or local benefits from projects are sufficient to justify local financing for projects that also further national goals. The results presented above average across some state programs in which more federal aid could have been used on viable projects, along with others in which no additional projects were financed by the extra funds. The results for state and local ABC highway systems show this variability--thinly populated western states expanded highway programs with federal ABC aid, though nationally, the aid substituted partly for state funds.[10] Variation in local financing capacity is also seen in the different cost-sharing agreements originally proposed by the Corps of Engineers for new water resources projects in its 1986 budget submission. Nominal local cost shares for new starts recommended by the Corps since 1983 have ranged between 35 percent and 100 percent, with an average of 57 percent. Administrators of some discretionary programs have been able to vary project finance conditions other than the local cost share in ways that change the effective federal share of project cost, and thus distribute federal subsidies more closely to the need for subsidy than would fixed-share formula aid. Cutting back in areas in which federal funds have substituted for state or local programs would not generally reduce these programs commensurately, but would allow federal aid to be channeled to infrastructure programs that are currently underfunded, thereby promoting additional investment. Thus allowing nonfederal applicants to negotiate both types and conditions of aid could help avert unnecessary demands for subsidy.

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8. Gramlich, op.cit.

9. Consad, op.cit.

10. Miller, op. cit.

Tax Exempt Bonds

Of all the federal mechanisms for financing investments, tax incentives rely most on local appraisals of investment opportunities. Indeed, many projects financed by tax breaks proceed through planning and construction phases with little federal intervention, though some may have been prompted at the outset by federal mandates (air pollution control projects, for example) or other standards. Local scrutiny, however, can be more stringent, as when users or taxpayers are asked to approve a bond issue for project financing.

But the detailed local scrutiny and concern with project viability is obtained at high cost. First, tax-exempt financing displaces taxable investment, and thus it reduces federal tax revenues. Further, a lower interest rate means that the project being financed will often supplant higher return projects in capital markets, since the two appear equally attractive to lenders such as bond buyers. Moreover, the current differential between taxable and tax-exempt returns, about 25 percent, provides a larger subsidy to those investors in the highest income brackets than the subsidy just needed to induce those investors to purchase the bonds. These investors are therefore encouraged to favor investments with tax-exempt financing over taxable projects of equal or greater national return, or lower risk. Second, except through such broad measures as the *per capita* limit on tax-exempt industrial development bond issues imposed in 1984, the Congress has no way of determining how much of the federal budget is to be devoted to these investments, nor can it gauge whether national objectives are being sought. No control is exercised over either the allocation of the financing among different types of projects, or the national priorities implied in federal support for the mix of projects chosen.

Between 1980 and 1984, federal tax revenue losses associated with tax-exempt investment financing increased by more than half.[11] Almost all of the increase arose from the post-1981 growth in the volume of debt outstanding; little stemmed from increased bond yields. Bonds sold for all purposes--including infrastructure, utilities, and other industrial projects--raised $116 billion in financing in 1984, compared with the annual rate of around $49 billion in the late 1970s (see Figure 5). Though bond issues financing traditional public purposes have contributed significantly to this rise--transportation issues, for instance, increased sevenfold between 1980 and 1984, and those for water and sewer system development rose by 130 percent--the largest volume increase was in so-called "nontraditional"

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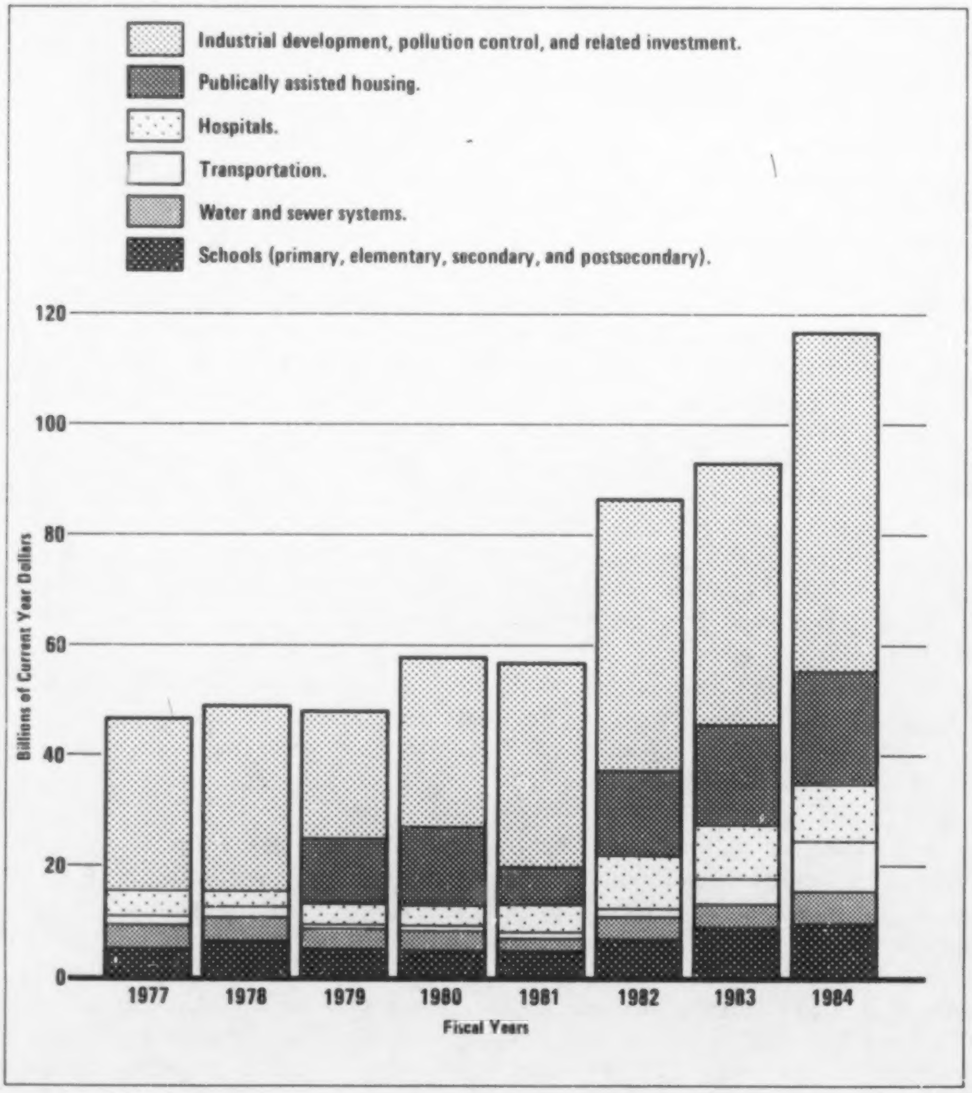
[11] Data in this section on federal tax revenue losses are taken from Office of Management and Budget, Budget of the United States Government, Special Analysis G, various years.

Figure 5.
Nonfederal Bond Financing by End Use: 1977-1984



SOURCES: Congressional Budget Office data and information from *The Bond Buyer's Municipal Handbook '84*, page 8 and Department of the Treasury, *S01 Bulletin* (Summer 1984), page 107.

percent--the largest volume increase was in so-called "nontraditional" borrowing (that for industrial and other economic development). This now accounts for more than half of all municipal debt issues.

The importance of federal tax subsidies for infrastructure development varies considerably among programs. For airport development, for which the responsibility for infrastructure financing is *de facto* borne locally, tax expenditures in 1984 added around half the amount of direct federal grants to federal capital subsidies. In transit, for which federal grant programs have expanded to provide significant direct assistance to most local operators, tax subsidies are incurred only on behalf of the larger agencies whose formula apportionments do not cover all capital projects. Even so, tax expenditures on transit bond issues add 10 percent to general federal capital assistance through formula grants. The additional subsidy for the construction of wastewater treatment plants may be around 8 percent of EPA construction grants. Though details are insufficient to make similar comparisons for other programs, tax losses probably add similar unplanned subsidies to all other infrastructure spending.

CHAPTER VII

WAYS TO RECAST THE FEDERAL ROLE IN INFRASTRUCTURE MANAGEMENT

A broad-based recasting of the federal government's role in managing public works infrastructure could build on two aspects of the management system:

- Improving the information from federal agencies on which the Congress bases its budgetary and policy decisions, and
- Improving the incentives to state and local managers to further national objectives.

When properly balanced and integrated, adaptation directed toward these two wide goals could offer long-term resolution of problems now impeding optimal infrastructure management. These problems include disregard of evolving conditions, overinvestment in ineffective systems, diversion of national resources to purely local purposes, failure to gather information from users about demand, and inability to maximize system efficiency through pricing.

Any Congressional effort to improve infrastructure management must, however, take account of the constraining reality that the federal government now provides financing for more than double the volume of investments it actually controls. The predominant federal role is in providing financing for investments made by other governments. Except in the direct investment programs, Congressional decisions about allocation of recourses are made at the program, rather than the project, level. For about 20 percent of investment, however, federal programs directly provide infrastructure systems or collaborate with state or local agencies in planning or operating facilities. Thus, the functions of identifying and appraising project choices are carried out in both federal agencies and state and local institutions. The Congress' allocation decisions therefore rely on information on program needs provided in large part by federal agencies, and on sound project selection made by states and localities. Hence, improving federal infrastructure management requires improved information about progress and effectiveness of programs, and improved incentives for state and local infrastructure choices.

IMPROVING MANAGEMENT INFORMATION

With only a few exceptions, most information that federal agencies provide to the Congress regarding infrastructure programs is descriptive. By and large, it is limited to reports that support budget requests. These reports detail how spending would be distributed over different agency activities (such as salaries, travel, equipment purchases, grants, and other subsidies), as well as over different program activities within a given agency (for example, Interstate Highway System construction, Primary system highways, and safety programs). Such reports display variations from current spending for each program activity. And to accommodate policy changes as they affect each budget account, a projection four years beyond the budget year shows expected variations from the level of spending suggested by "current services" spending.

Though the Congress also receives periodic status reports on programs from agencies, these vary in frequency and coverage. The Federal Highway Administration, for example, submits an annual report on the bridge program, and biennial reports on highway conditions and performance. The Environmental Protection Agency presents "needs surveys" for wastewater treatment every two years. Water resources and power programs, however, have no regular status reporting requirements, though the Army Corps of Engineers makes special reports from time to time--for example, its surveys on dam safety, the most recent in 1982, and the national waterways study in 1983.[1] In 1984, the Urban Mass Transportation Administration (UMTA) made the first of a series of biennial reports on the status and future requirements of the mass transit program.[2] Such reports tend, however, to concentrate on the current condition of infrastructure, and on estimates (akin to needs estimates) of the spending required to bring that condition to some preferred level over a specified time.

Rarely do agencies formally examine the effects of eligibility rules for financing or standards for the efficiency of the investments made with federal assistance. Even more rarely do they monitor programs against broader objectives. The current services baseline on which each program is based presupposes a constant level of service, disregarding changed conditions or the spending profile of large investment projects. Reviews of the overall effectiveness of programs, or of the management gains from administrative changes within programs, are available to guide policy formation only sporadically, and only as a result of special requests.

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[1] See U.S. Army Corps of Engineers, *National Program of Inspection of Non-Federal Dams, Final Report to Congress* (Washington, D.C., May 1982) and *National Waterways Study--A Framework for Decision Making* (Washington, D.C., January 1983).

[2] Urban Mass Transportation Administration, *Report of the Secretary of Transportation to the United States Congress* (Washington, D.C.: UMTA, September 1984).

Thus, significant opportunities are available to the Congress for improving and making routine the information needed in deciding appropriate amounts and types of spending on different goals. Similarly, information could be provided for overseeing the effectiveness of current policies and practices. Possible management changes could fall into three different categories:

- Broadening the context of budget requests to that of a development plan,
- Using agency reports to examine the past effectiveness of policies, and
- Altering the format of budget requests to require consistent use of evaluation parameters.

Adopting any of these policies or combining several would encourage federal agencies to make better use of analytic methods for monitoring and relaying information about the programs they manage. The reports to be required would be specific, budget-oriented studies. They would, however, be distinct from those in common use now in that they would explain and justify spending requests in relation to program goals.

Sector Planning

To provide a more informative context for legislative consideration of requests, the Congress could require agencies to prepare "sector development" plans. These would set out the long-term goals of individual infrastructure programs, how a current plan aspires to achieve them, by when, and at what cost.

An example of considerable success with this approach is readily found in the Interstate Highway System's construction program. On the basis of the network mapped out during the 1940s, the construction plan adopted in 1956 included the other elements of the strategy needed to realize its objectives. First, consideration of the implementation capacity for the (then-to-be) 41,000-mile network led to a 15-year construction period, with a "halfway" target set at the end of 1964 and completion planned for 1972.

Second, financing arrangements were carefully devised. A federal commitment for the entire program was established through a trust fund offering 90 percent of construction costs to states; at the end of 15 years, the trust fund was to expire. Meanwhile, taxes were enacted for the duration of the trust fund to finance construction.

This plan allowed the Congress to monitor progress and modify arrangements as needed. Swift action to increase revenues averted financial crises for the trust fund in 1959 and 1960, when the initial cost estimate proved too low. Following a cost allocation study, action was again taken in 1961, this time adjusting tax rates to distribute the burden more fairly among users. With the aid of financing changes, construction of the Interstate system proceeded roughly at the pace first planned. By early 1963, a total of 14,600 miles of the system were open to traffic, and construction was under way on another 5,000 miles. Thus, states were well along toward meeting the "half open" target set for late 1964. Tight monitoring continued through the 1960s. By early 1966, work was complete or under way on 94 percent of the network. (Cost increases from inflation and design changes, together with reluctance to raise taxes to finance them in the latter part of the 1960s, however, finally led to postponing the remaining targets for completing the network.)

Thus, by establishing performance standards that meet program targets, sectoral plans improve discipline both for agencies administering programs and for aid recipients. Such plans would provide the Congress with a ready system for measuring progress and assessing possible adjustments. For programs that support continuing investments (such as 4R highway aid), plans could be presented as rolling, three- or five-year programs reflecting current and projected infrastructure conditions and user demands.[3] Progress could then be monitored against condition ratings; an example is the serviceability rating now used for highways (see Chapter III). Programs supporting single-purpose investments, on the other hand--such as in air traffic control or wastewater treatment--could be monitored directly against the purposes they serve.

Considering budget requests in the context of sectoral development plans would also give the Congress important information about the extent of flexibility in infrastructure programs. Many large projects require appropriations over several years to complete construction. Thus many programs carry forward a high degree of dedication to past decisions. The extent to which a current project approval will commit future resources, and the latitude in existing programs to accommodate new undertakings with or without overall spending increases, could be determined more meaningfully in the context of a sectoral plan. Such plans would project more realistic estimates of future spending than under the present, implicit assumption that current-services spending levels will continue unchanged unless policy is revised. Indeed, changes from current spending levels might be needed to achieve policy objectives.

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[3] The federal budget process could be severely burdened if lengthy procedures were required to support each annual cycle. It would be possible, however, to devise realistic three- to five-year evaluation cycles for major programs, with intervening years presented under the present approach. Such cycles for program evaluation could be particularly supportive of the multiyear authorizations now common for federal trust fund programs.

But plans are difficult to change. Though planning reduces the chances of mistakenly ignoring or excluding initiatives that further a program's objectives (or of including unneeded undertakings), it also raises difficulties for incorporating changes found later in the planning process to be beneficial.[4] Planning must balance being so flexible that consistent purpose is lacking; it must also balance being so rigid that needed changes cannot be agreed on among plan sponsors. Further, to be effective, sectoral plans must count on actions on the part of states and localities. States may be less receptive to federal monitoring on general programs than on, say, Interstate highway construction, because of the latter's federal nature and sizable state benefits. Targeting in other programs has been less successful. Communities nationwide, for example, circumvented the intentions under the Urban Development Action Grants program to aid economically distressed areas-- 80 percent of all cities applying, or more than 2,200 in all qualified as eligible for aid. In all cases, substantial intergovernmental agreement on plan goals and means would be needed to make sectoral planning workable.

Ex Post Evaluations from Program Managers

Program reevaluation that looked at general groups of projects or at types of financing arrangements could provide advice on how well management was performing and could alert the Congress to any constraints impeding improvements. World Bank practice offers one example of the kind of *ex post,* or after-the-fact, reporting that could prove useful. The Bank conducts two retrospective reviews of each project it helps to finance. The first is conducted by project staff of the Bank or its borrower, and the second by an independent group. The reviews serve two broad purposes. First, since they are to be held accountable, project planners tend to be less overoptimistic. Second, through an annual synthesis of audits in each general sector, broad classes of project management or design adjustments are identified to help shape future projects.

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[4] As discussed in Chapter III, for example, planners found difficulties in adopting a scheme for bus improvements even though they found it offered greater benefits than the rail scheme originally set up for evaluation; the very large lists of water resources projects illustrate the difficulties of changing plans in that sector.

No U.S. infrastructure agency, however, regularly reports to the Congress on the effectiveness either of policy administration or of changes that would enhance infrastructure management. In the U.S. federal environment, similar project-by-project audits would probably not be feasible, largely because the selection and management of projects is performed in the states. Those few status reports presented tend to concentrate on current physical conditions and to summarize past and future spending options. Such policy reviews as are done are rarely carried forward to support changes in budget requests. Proposals to change policies come more often from outside the agencies than from the administrators most familiar with the management of the programs.

In the course of their ordinary work, many agencies do obtain information on the effectiveness of certain policy approaches. Some comes from contacts with state counterparts; state complaints about the cost-increasing effects of federal highway design standards, for example, are widely reported. More comes from special studies financed under a program itself, such as the Department of Transportation's Technology Sharing program. 5/ Reviews of program effectiveness, extended by a Congressional requirement to formal reevaluation of the program overall, could uncover management changes that would improve the efficiency and responsiveness of infrastructure programs.

Federal managers might regard the reevaluation process as divisive. Further, staff closely involved in program administration might have difficulty in making objective reassessments of the program's performance. On the other hand, much would be lost by assigning the review process to an outside body, whose findings could then be debated or negotiated with the program agency under scrutiny.

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5. This program finances and distributes studies and reports on different management, planning, engineering, and operational practices in transportation.

Applying Consistent Evaluation Parameters

The use of consistent evaluation parameters for all agencies would greatly assist the task of making agency budget requests more informative for infrastructure management. Federally supported statements of environmental impacts, analyses of alternative transit proposals, and justifications for water resources projects would all offer discounted life-cycle benefits and costs to compare against unevaluated environmental or social impacts. All agencies would apply to their projects a discount rate reflecting expected long-term borrowing costs (see Chapter III). Looking toward a longer-term goal, all agencies could be required to present comparable information for all capital spending on either a program or project level, whichever one was appropriate.

Rather than devise some uniform presentation for all agencies, use of consistent parameters would require that each agency stay abreast of developing evaluation methods and their applications in the agency's technical field. (Consistency generally does not imply standardized values for most parameters.) Other than the discount rate and the life-cycle approach, values for similar impact measures in different projects or systems would probably differ. Behavioral studies have shown, for example, different values for travel time savings, depending on purpose or journey, mode, and journey stage, and reflecting the different importance travelers place on time spent waiting or traveling under various circumstances.[6] The effects of traffic noise and the wishes of localities to suppress or divert it, similarly, are one thing for highways and another for airports. In requiring consistent evaluations, therefore, the Congress would simply have to specify that agencies use the expected federal borrowing rate for discounting and follow the best available practices to evaluate lifetime outcomes for project and program proposals. The purely technical task of determining appropriate methods and parameters for other elements would remain within federal agencies.

Two risks attend encouraging agencies to present evaluation results to support budget requests--agency inertia and excessive zeal. To equip themselves to conduct evaluations, many agencies would have to invest in significant personnel adjustments. Avoiding delays would require vigilance in supervising the changes, and perhaps some incentives for early adoption of analytic methods. At the other end of the scale, adopting too stringent standards for project studies could markedly inflate the cost of budget preparation. Already, the formal procedures for preparing Environmental

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[6] Such evaluations can be important in transport evaluations.

Impact Statements or Alternatives Analyses are formidable, but their impact on budget choices (as discussed in Chapter III) is not always commensurately beneficial. Planning guidelines for both the Corps of Engineers and the Bureau of Reclamation indicate a four- to five-year duration for feasibility and appraisal studies.

IMPROVING THE INCENTIVES TO NONFEDERAL MANAGERS

To sharpen the incentives to states and localities to make efficient infrastructure choices, six possible changes in allocation rules or management policies themselves could be considered:

- Reducing federal aid,
- Developing "sunset" conditions for some programs,
- Altering matching shares,
- Using broader financing categories and block grants,
- Using innovative financing techniques, and
- Restricting aid eligibility by performance targets.

The first three areas of possible change rely broadly on the principle that, faced with greater shares of costs, states and localities will make more efficient choices among infrastructure options. The third, fourth, and fifth also incorporate features encouraging greater competition for funding among potential projects--a tactic found to sharpen infrastructure choices.[7] All of these five strategies aim to improve infrastructure management by encouraging wider searches for and better appraisals of the opportunities available; both are needed to ensure the continuing responsiveness of infrastructure systems to national economic and social purposes. The sixth suggests possible direct federal actions that would encourage the same end by rewarding program agencies that use preferred management practices.

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7. As discussed in relation to the transit transfers and substitutes for uncompleted Interstate segments in Chapter II.

Reduce Federal Aid

State and local determination to complete infrastructure projects would exert great influence on the outcome of reduced federal financing. If federal contributions to public investments for infrastructure programs were reduced, states and localities should invest more, not less, to assure the completion of projects. To the extent that states and localities partially substituted federal funds for their own revenues (as discussed in Chapter VI), adjustments in the relative shares of federal *versus* state and local financing might be accommodated without serious interruption of an overall program.

Reduced federal funding would make local agencies more reliant on local budgets for investment and operating resources. This greater local responsibility might well stimulate use of better techniques for priority setting. Local consequences and costs would be reflected in choices of projects consistent with local willingness to pay. Greater management responsibility would tend to direct planners' attention to cost saving options.

A disadvantage of reducing federal shares is that, while management effects are likely to be positive, equity and efficiency issues might arise. Equity concerns stem from a generally more regressive overall tax structure in states and localities (based largely on fixed-rate-per-dollar property or sales taxes) than in the federal system, in which some 70 percent of all tax revenue is collected through progressive levies on income. For state and local infrastructure systems, financing from special user taxes rarely provides reserves for renewal or expansion of assets. The burden of infrastructure financing from state and local sources therefore tends to rest on general taxes, and thus it falls relatively more heavily on less-affluent groups of taxpayers. The Bay Area Rapid Transit system in the San Francisco Bay area, for example, financed all construction until 1973 from bond issues; these were to be repaid from property and sales taxes. A review of the relative burden of bond repayments between 1964 and 1990 estimates payments averaging 0.66 percent of the annual income of a family of four living at the poverty level, and 0.56 percent of the income of a retired couple, compared with a 0.24 percent (or less) of income levy on affluent families. 8/

Furthermore, if states and localities were to make up reduced federal spending from tax-exempt borrowing, a hidden (and largely unmanageable)

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8. See McDonald & Grefe, Inc., *The Economic and Financial Impacts of BART* (Washington, D.C.: U.S. Department of Transportation and U.S. Department of Housing and Urban Development, April 1979).

subsidy, in the form of uncaptured revenues, would augment the federal costs. Overall federal support for infrastructure could still be lower than under current policy, but nonetheless sizable. A $100 million 30-year tax-exempt bond, for example, leads to federal tax revenue losses equivalent to $40 million over the bond's life, which would come to half of a federal grant costing of $80 million.

A perhaps more important drawback is the possibility that states might tend to disregard harmful spillovers from their projects to residents in other states, or fail to incorporate project features benefiting residents of other jurisdictions. Much federal involvement in infrastructure planning aims to encourage states to invest more than they otherwise would to mitigate adverse effects--say, congestion or pollution clean-up costs--on other localities. The importance of this is mostly in projects with interjurisdictional effects, including transportation and wastewater treatment.

Developing Sunset Conditions for Programs

All policy programs inevitably reach a mature stage at which their missions are complete or nearly so. 9/ After 160 years, the Corps of Engineers, for example, is finding increasingly few opportunities for improving inland or ocean navigation. With an average pavement rating of "good" or better on all federal-aid highways (except low-density rural and urban collectors), purposes of the long-standing assistance for state and local highway systems might also be regarded as mostly accomplished. Transit bus fleets have also been substantially modernized; they now have an average of eight years in service compared with a planning life of 12 years and a maximum of 20.

Developing "sunset" conditions--that is, establishing expiration dates and/or conditions--for all federal assistance programs would clarify both the federal view of the purposes and permanence of each program, and recipients' expectations of federal aid. Sunset conditions would also ease the transition from outdated to new orientations in program goals, and would enhance any sectoral planning activities of program agencies. Setting a termination date on federal aid for transit system modernization, for example, could be coupled with a new program supporting transit investments that would avoid the expansions of urban road systems made necessary by shrinking transit use in cities. Knowing such sunset conditions, local agencies would be encouraged not to delay providing facilities from their own resources in programs in which they do not meet the cutoff provisions.

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9. See Congressional Budget Office, *Public Works Infrastructure*, Chapter I.

States and localities would be encouraged to develop financial support systems for infrastructure initially provided with federal subsidies. As a result, the practice of financing first the investment, then its renewal or replacement (as has become common in federal programs) could be avoided. With an end to federal aid in view, local program administrators might become reluctant to finance cost overruns resulting from poor local planning or inadequate engineering practices.

But sunset provisions for infrastructure programs would complicate Congressional decisionmaking and oversight. Unless derived from pre-set termination dates, they might elicit little more than *pro forma* review. They might also divert agency managers from monitoring progress toward long-term goals toward developing political support for their programs. To date, success in achieving termination on programs slated for it has been rare, but it has been achieved for programs for regulating transport operations, substantially since 1980. The five-year phaseout for federal assistance for construction of wastewater treatment plants proposed in 1985 extends the principle to capital programs.

Altering Matching Shares

Federal aid for the Interstate Highway System now provides 90 percent of costs, but for construction of wastewater treatment plants, just 55 percent. The generosity of federal shares of ongoing operations and maintenance costs also varies greatly. Federal contributions cover 90 percent of major maintenance and rehabilitation of the Interstate system and 75 percent for state and local roads; routine maintenance, however, is funded locally. Operations and maintenance expenditures of the Corps of Engineers and the Coast Guard cover all routine and major maintenance of the inland and ocean navigation systems. Users pay fees to recoup all the operating and maintenance costs of wastewater treatment. These variations are reflected in different life-cycle support from federal sources in different programs. Overall, the effective composite federal share of water resources projects --computed as the discounted capital and operating costs over the useful life of the assets--varies from an average of 80 percent for Corps-managed projects to 51 percent for those of the Soil Conservation Service. 10/

Using a composite match reflecting a combination of capital and operating subsidies would avoid distortions arising in differences between

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10. See Congressional Budget Office, *Efficient Investments in Water Resources* (August 1983).

federal *versus* state and local preferences for capital and operating solutions, depending on the cost burden each governmental level bears. Using a maximum, rather than a fixed, match would allow states, cities, and counties to distribute subsidies from formula aid according to local priorities. Further, to the same end, federal managers of discretionary aid programs could negotiate cost sharing with recipients. In principle, matching shares negotiated between federal agencies and local project sponsors could tend to focus aid on projects or project components that states are reluctant to fund but that have large beneficial spillovers. Federal aid for such projects, for example, could be provided on more generous terms than projects of more predominantly local interest. Thus, no community would receive automatic subsidies on projects that are larger than needed to align choices with national priorities, nor would it receive less in other areas to achieve the same end.

For wastewater treatment investments, analysis has found that an average federal capital match of about 55 percent encouraged efficiency, but that higher federal cost shares coincided with higher overall costs. The Corps' negotiations on cost sharing for water resources suggest a local willingness to pay between 55 percent and 60 percent of capital costs.

With negotiated matching for infrastructure financing, therefore, a lower average federal capital match than the current 80 percent seems a reasonable expectation. Though the effect of reduced federal shares on substitutions between federal and local infrastructure funding has not been studied, it seems that reduced federal matches would more likely lower federal costs than increase spending significantly.

In the long run, altering federal infrastructure financing to negotiated cost shares that were lifetime composites would tend to lower both federal and total infrastructure costs. It would do so by encouraging both federal and local program managers to favor choices with highest benefits or lowest costs, without regard to the balance of the options' capital and operations cost. The immediate effect, however, would probably simply be a change in the timing of federal and local contributions--with higher local shares early on during construction, and higher federal shares later in operations and maintenance.

Smaller communities or agencies with constrained resources, however, might have difficulties competing against agencies that, from a state-wide or city-wide perspective, can use higher local matches as a leverage for further federal aid. Similarly, financing very large projects, which would cut into resources available for all other programs for perhaps several years, might become relatively unattractive.

Broad Financing Categories and Block Grants

Widening the categories of projects eligible for assistance under any one program, or even broadening categorical aid to block grants for infrastructure, offer opportunities for improving infrastructure management. Except in special cases--such as the provisions cited earlier permitting transfers of Interstate aid to mass transit--recipients of federal aid now have little flexibility to distribute federal assistance among their infrastructure programs. As reported in Chapter II, however, the Interstate transfers and substitutes have generally disciplined priority setting for Interstate highway construction.

Such broadening would follow the outlines of actions made in urban programs during the Nixon Administration (for example, Revenue Sharing and Community Development Block Grants) and suggested for social programs early in the Reagan Administration. Unifying funding sources for infrastructure could be done on a small scale. The 47 programs financed from the Highway Account of the Highway Trust Fund, for instance, could be merged. This would help prevent overspending on state and local systems while the Interstate system deteriorates (as was found to be occuring under separate maintenance programs). Or more ambitiously, all transportation subsidies could be combined into a single transportation block grant administered by recipient states. This might encourage more trade-offs between projects in different modes, as was found beneficial in examining the Interstate transfer and substitute programs. All infrastructure aid could be provided in an omnibus grant, distributed by formulas reflecting the extent and performance of component systems. Minimum performance or eligibility criteria could be specified to guide the distribution of funds below the state level. So broad an approach would extend the principle of wider searches for effective improvement options to include all federally supported programs.

The advantages of broad aid categories lie in the stronger influence of state and local budget making on project selection; all infrastructure agencies would receive resources through local budget processes. States could set priorities and distribute funding after considering all resources available from both federal and local sources.

A disadvantage would be the potential for diverting funds to purposes not related to infrastructure. Now, state funds freed by federal assistance are largely spent on the aided system but on unaided activities. State expenditures for construction and major repair of unaided highway systems have been found to increase by about one dollar for each dollar in federal grants for primary, secondary, and urban roads. [11] This may be because of the relative financial independence of agencies receiving federal aid. With block grant disbursement covering several systems, however, spending might spill over to other programs of lesser federal importance. The CDBG programs, for example, have been much criticized because cities did not confine their project selection to the employment-creating development investments in distressed areas targeted by the categorical programs they superseded. [12]

New Financing Mechanisms

A new concept in infrastructure finance is that of an infrastructure revolving fund or bank. At the federal level, two different proposals for revolving loan funds for general infrastructure financing are currently being considered, as well as proposals for a fund to finance wastewater treatment plant construction. [13] Several states have established or are well along in planning for similar institutions, some for multipurpose assistance and some targeted for the neediest counties.

The general format involves a fund, capitalized with government contributions, to lend for infrastructure projects. Reimbursements are then lent again for further projects. [14] Suggestions for capitalizing the funds have included long-term interest-free loans, federal grants matched by states and localities, earmarked tax revenues and, for the banks, borrowing from capital markets. Loan terms, similarly, vary among proposals, depending on policy choices and the costs of loan funds. Because subsidies are provided through government capital contributions, most proposals being discussed could offer project loan terms better than the rates in the municipal bond market.

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11. See Harry G. Meyers, *Displacement Effects of Federal Grants for the Primary, Secondary and Urban Federal Aid Highway Systems*, Office of Management and Budget Special Studies Division, July 1985.

12. See, for example, M. Carter McFarland, *Federal Government and Urban Problems: HUD: Successes, Failures, and the Fate of Our Cities* (Boulder, Colorado: Westview Press, 1978).

13. Proposals for new revolving loan funds for infrastructure are set out in H.R. 1776, H.R. 2818, H.R. 8, and S. 1128 of the 99th Congress.

14. The broad principles of organizing revolving funds are discussed in CBO Staff Working Paper, "Infrastructure Revolving Funds: A First Review" (May 1985).

Revolving loan funds have several features in common that make them attractive for pursuing management improvements. First, competition for relatively scarce loan funds would likely encourage careful scrutiny of project proposals. Fund administrators, for example, would want assurances that loan repayments could be made. Project planning would therefore have to include financial projections for the completed investments, as well as engineering and technical designs. Second, infrastructure managers using loans to finance their projects would be more likely to pay attention to proper pricing of their services, and might be encouraged to set up reserves for the renewal of their assets.

Loan repayments could also reduce the federal cost shares for any volume of project investments. A wastewater revolving fund wholly capitalized from federal sources, for example, could offer 20-year loans at 5 percent interest for a net long-term federal cost share of 40 percent, compared with 55 percent under the current construction grants program. Interest-free loans with 20-year terms for infrastructure could be provided at a 60 percent federal match, compared with the present average 80 percent capital share for federal grants. Moreover, to the extent that repayments were made from user charges, this would present an equitable way to lower federal matches or reduce federal participation in programs.

Disadvantages in revolving funds lie in the risks of default by borrowers and in the influence of subsidies on project choices. Defaults, of course, reduce the resources available for both good and bad projects. A single major default, or simply a poor record of collecting repayments, can jeopardize the overall financial stability of a fund. Revolving funds also exhibit the disadvantages of earmarking characterized by trust funds (see Chapter VI), hampering efforts to redirect surplus balances or revenues not needed for the programs financed.

Moreover, to be effective in improving infrastructure management significantly, such funds would have to finance most, if not all, of relevant investments. More creditworthy borrowers might prefer to borrow directly from capital markets, since they might have better credit ratings than the fund. Loan portfolios of the revolving funds might therefore include a large portion of risky borrowers, which would increase the chances of the funds having to make repeated calls for government aid for recapitalization. For funds set up to serve as new infrastructure financing sources, this could be especially relevant. Agencies substituting revolving loan funds for capital grants would receive lower subsidies than are received now, and the incentives for careful project design and selection would be heightened. Agencies with poor projects and poor credit ratings, however, would also tend to be attracted to revolving funds, since the funds would usually be able to offer (average) financing terms at below-market rates by averaging their riskiness with more creditworthy projects. Unless strict risk assessment and repayment policies were enforced, this would tend to erode the overall creditworthiness of revolving funds.

Focusing Aid

To promote better management practices, federal aid could be dispensed conditionally. For example, aid could be "tranched," or parceled out, in different priority groupings. Accordingly, financing could go first to those rehabilitation or renewal projects not adding to capacity or to those expansion projects for which overall productivity for the existing sections of the system reaches efficient levels, since these projects would tend to show the highest returns. Priority financing for such projects would help ensure that rehabilitation and expansion options were considered during project design, as well as operational and management options for productivity gains. Other projects would then be financed from residual funds. Alternatively, using management criteria, preference could be given to all projects that incorporate elements to extend the useful lives of facilities (including using improved pricing--see Chapter V), or that develop strategies for providing reserves for asset replacement or renewal. Most bus companies modernized with federal assistance, for example, rely on further assistance to replace their renewed fleets as buses reach the ends of their service lives. This perpetual cycle could be avoided if assistance for modernization were tied to conditions ensuring either the accumulation of reserves or changes in pricing policy.

Local infrastructure agencies, however, might resist federal performance criteria as conditions for aid. Nevertheless, performance covenants are common in commercial contracts, and in municipal borrowing for capital projects, financial reserve requirements are typically agreed on with underwriters. Stricter conditioning of federal assistance would encourage agencies to seek efficiency-enhancing practices that would attract preferential aid, resulting in generally better planning and maintenance.

Nationally applicable federal standards would have to be set with care. Standards for operational efficiency cannot be too broad or too rigid to reflect the varying circumstances of different regions. Because of this delicateness, conditioning federal assistance might also lead to a larger supervisory effort on the federal government's part, and to what might be seen as undue interference with local management. As with modified financing, however, the benefits of changes in aid conditions designed to improve infrastructure management rely on stronger state and local budget procedures, rather than on a stronger federal influence.

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